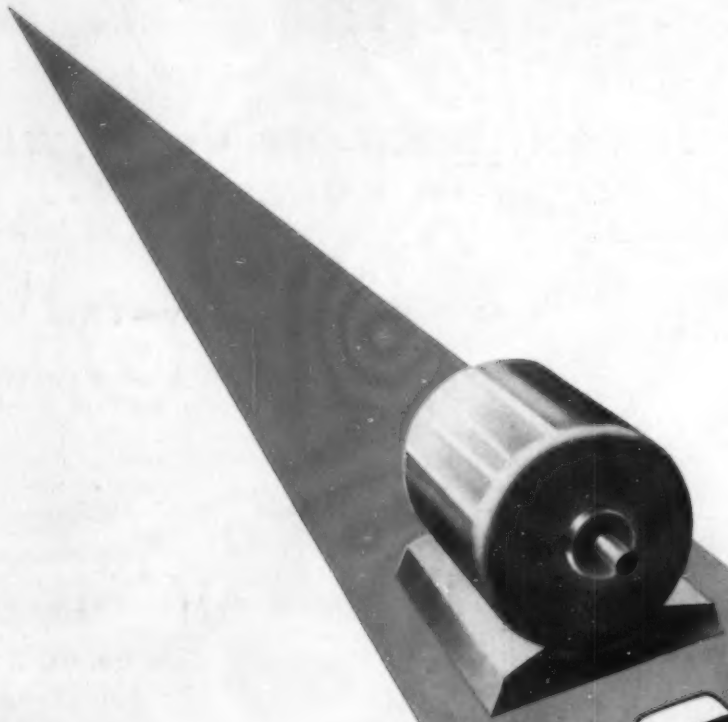
GE's proven method for...
SELECTING MAINTENANCE MEN ► 117

Power

JUNE
1955·50¢

GENERATION, TRANSMISSION AND APPLICATION OF THE POWER SERVICES • A McGRAW-HILL PUBLICATION



TODAY'S BETTER MOTORS

a report on new designs ► p 73

BUT THERE IS A LOW COST WAY TO STOP POLLUTION...

WITH THE A-S-H LOW PRESSURE SYSTEM

Most pollution control systems—high pressure systems—are expensive—expensive to install, costly to maintain, costly to operate.

The most efficient and economical answer to pollution control problems—*where ash or dust is the contaminant*—is the A-S-H Low Pressure Hydraulic Recirculating System. You will save money four ways:

1. On Installation. A-S-H designed systems are simpler, require less expensive components and are more easily installed.

2. On Operation. Power consumption is low. One A-S-H *Hydroseal Ash Pump* is sufficient for most systems.

3. On Water. Where water is scarce, the system can be completely closed, eliminating any outflow of polluted water and requiring only a minimum of water for make-up.

4. On Maintenance. No periodic cleaning is required. Wearing parts last longer on A-S-H *Hydroseal Ash Pumps*, which means lower replacement costs.

If you have a problem involving ash or dust disposal, do not overlook the advantages of A-S-H Low Pressure Systems. An A-S-H Materials Handling Engineer will be glad to discuss your problem with you—without obligation, of course. Or, if you prefer, write Dept. A1, requesting Data Sheet Pa which describes the A-S-H *Hydroseal Ash Pump*, the heart of the A-S-H *Low Pressure System*.

The **Allen-Sherman-Hoff** Company

259 E. Lancaster Ave., Wynnewood, Pa.

Offices and Representatives in Principal Cities

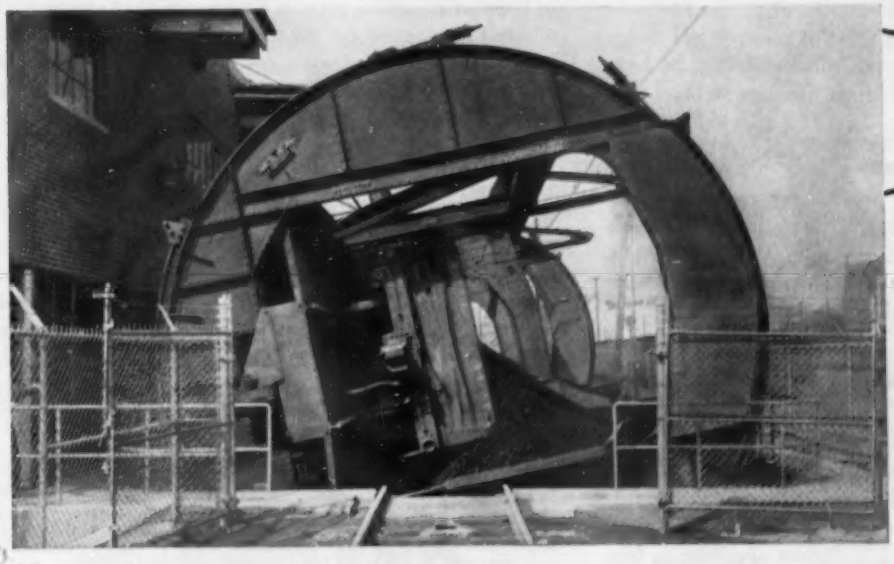
MATERIALS HANDLING SYSTEMS

hydrojet *hydraulic* / **hydrovac** *pneumatic*

How many railroad cars does your plant unload?

15 or more cars per day?

Car Shakers. Cut unloading time, free manpower. For example, where a load of wet coal ties up three men for ¾ of an hour, one man with a Link-Belt Car Shaker can empty the car "broom-clean" in minutes. Exclusive low-frequency vibration minimizes noise . . . is easier on cars. Write for Book 2345.



15 or more cars per hour?

Rotary Dumpers. Empty a 90-ton gondola car every 60 seconds or less (including return to upright position) by turning car upside down! Simple, automatic, foolproof. Takes all open-type cars—any length, width or height. Book 2048-A has complete data.

Choose the LINK-BELT Car Shaker or Rotary Dumper that meets your operating needs

Push-button emptying of gondola cars is a sure, simple step to substantial time and manpower savings. And only Link-Belt builds car shakers *and* rotary dumpers . . . to meet all unloading needs, from the largest to the smallest. Both are precision-engineered—each is designed to do a specific job faster . . . easier . . . at lower cost.

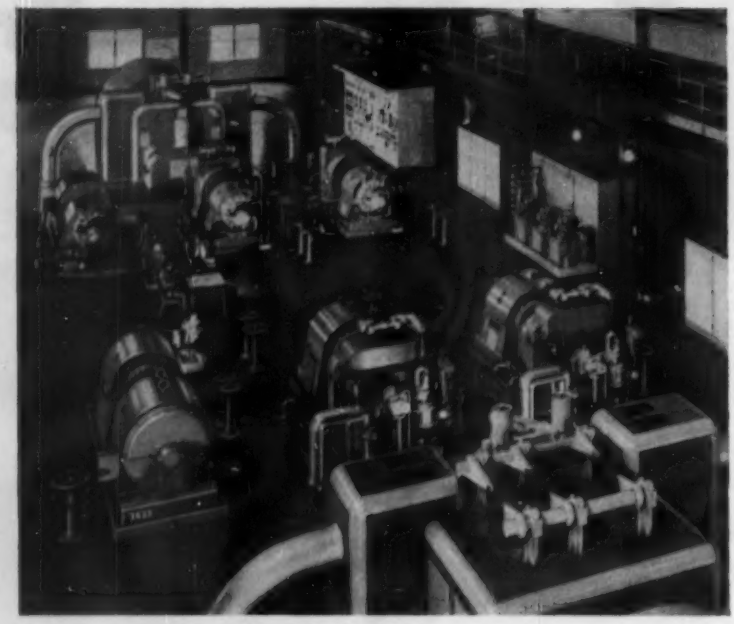
Further benefits of mechanized unloading are no less important. Operational hazards and injury possibilities are lessened. And you save demurrage charges. That's why—if your operations can be improved by rapid car unloading—it will pay you to get in touch with your nearest Link-Belt office.

LINK-BELT

CAR SHAKERS and ROTARY DUMPERS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,710

What makes a barrel-type boiler feed pump *stay in service?*



Here are some of the design features that assure dependability

Today's modern multi-stage centrifugal pumps for boiler feed service are the result of years of research and design. To provide efficient service *plus* dependability, De Laval has incorporated these important features in its barrel-type pump.

Double Volute Diaphragms

Double volute diaphragms provide for radial hydraulic balance and assure a continuous rising head characteristic from the design point to shut-off. *RESULT—Higher efficiencies are maintained over a wider range of operation than are generally obtained with other forms of velocity pressure conversion.*

Individual Diaphragm Bolting

Elimination of rabbet fits and gaskets permits straight metal-to-metal contact of adjacent lapped faces of the diaphragms which are individually bolted together to maintain tight joints and ease of assembly. *RESULT—Positive assurance against inner case leakage, complete elimination of misalignment causes and a minimum of distortion from sudden temperature changes.*

Positive Sealing Between Suction and Discharge Chamber

Inner assembly is held at the inner high pressure joint at the suction end of the barrel, against a flexitallic gasket, with through bolts. The joint between the suction and discharge chambers is made tight during assembly—remains tight whether pump is operating or idle. *RESULT—No possibility of leakage or gasket loosening due to changes of force on the inner joint.*

Bare Shaft

Bare shaft construction with split ring-shrink fit method of impeller mounting permits a scalloped shaft design and eliminates the need for spacer sleeves between impellers. *RESULT—Better hydraulic conditions at the eye of the impeller and elimination of spacer sleeves—the greatest cause of shaft warpage.*

Wearing Rings

Diaphragms and impellers have renewable wearing rings. Impeller rings are threaded on the impeller hubs against rotation, and diaphragm rings are held by a breech lock fit in the diaphragms. *RESULT—Construction permits renewal of original clearances without major part renewal or modification. Labyrinth type diaphragm ring results in minimum leakage over a longer period of time than with close clearance flat rings.*

IMO Oil Pump

A De Laval IMO pump designed for high speed operation is direct-connected to the outboard end of the barrel pump shaft, and is sized to lubricate both pump and driver bearings. *RESULT—Quiet, pulsation-free, positive displacement IMO pumps, assures positive lubrication and eliminates the need of extra shaft length and mechanical complications required by gear drive lube oil pumps.*

BULLETIN CONTAINS HELPFUL DATA

This De Laval bulletin on the barrel-type boiler feed pump covers all major design points . . . has cross-section cut-away illustration for easy reference. Write on your business letterhead for your copy of Bulletin 1506 to De Laval Steam Turbine Company, 815 Nottingham Way, Trenton 2, New Jersey.

Power

JUNE 1955 • VOLUME 99 NUMBER 6

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POWER articles are indexed in both the *Industrial Arts Index* and the *Engineering Index*. POWER publishes its own annual index.

MOTOR DESIGN, as dramatized on this month's cover, is shifting more into the power spotlight as industry continues its swing toward continuous processes and automated production. The designer is giving more thought to longer motor life with little or no maintenance required. Ultimate will be a more compact unit unaffected by ambient conditions and requiring no care during its life span. Motor makers are working toward that goal by concentrating on the two elements most affected: bearings and electrical insulation.

With cost of plant maintenance increasing because of more complex equipment and higher wages for maintenance men, power men have shifted their emphasis from first cost to real cost over the motor's life. By scrutinizing potential maintenance problems the initial cost figure is often dwarfed.

Next month . . .

Condenser-tube corrosion has been under long careful study at Montaup Electric's Somerset Station. Upcoming issue outlines latest results in fighting the battle against tube failure.

Bunker-C fuel oil needs some treatment before feeding to gas turbines. Work at Rutland Station, Central Vermont Public Service, points to washing, centrifuging for control of sodium-vanadium concentration and ratio. Read the timely facts in the July issue.

Refrigeration maintenance is a broad subject including motors, controls, lubrication, cooling circuit, and all the necessary paper work. This coming article outlines all the factors, based on plan being followed at Eastman Kodak.

Incentive bonus for your operators? It's still a two-sided question, so next month read a strong argument *against* paying.

. . . and future months

Modern Plant Yearbook Issue in mid-September is a 5-star hit. Watch for it!

1. Modernization awards announced
2. Modern-plant survey
3. Directory for modernization
4. Cross file of obsolescence
5. Engineers' new-product showcase

Heavy fluids can't hinder working parts in these CRANE VALVES

THIS CASE HISTORY tells how the United States Playing Card Co., Cincinnati, solved—with Crane Diaphragm Valves—a costly problem of piping heavy enamels for paper coating.

The trouble was in the plug cocks and conventional gate valves formerly used in the enamel lines. During normal shutdowns the heavy liquid would build up on seating surfaces, in stem threads and working parts. The cocks and gates would "freeze up" . . . were hard to operate . . . couldn't be shut tight. The condition hampered production . . . made floors messy and dangerous . . . pushed maintenance costs sky-high.

Replacing with Crane Packless Diaphragm Valves stopped the trouble completely. Their sealed-to-fluid bonnet and pliable neoprene disc insert did the trick. After more than 4 years, all 48 Crane valves installed—with no maintenance whatsoever—are still seating tight . . . still operating freely and smoothly.

CRANE PACKLESS DIAPHRAGM VALVES

Working parts are safely out of contact with line fluid. The diaphragm seals the bonnet—that's all it does, giving it longer life. The independent disc with pliable insert seats tightly on foreign particles or seat deposits . . . and controls fluid, even should diaphragm fail. See your Crane Catalog or Crane Representative for wide selection of body, bonnet, and trim materials in these valves for countless uses.

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CRANE'S FIRST CENTURY . . . 1855-1955

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...lines and bylines

Ty Hicks, Jim O'Connor, Althea Thornton study an older motor design

TODAY'S ELECTRIC MOTORS, POWER's latest staff report (p 73), breaks ground in introducing a new form of two-level reading as a reader timesaver. Now, by scanning illustrations, reading headlines and underlined text, you get a quick trip through the report. Who will benefit? Men who have kept abreast of recent motor changes and those who just haven't the time *now* to read the complete report.

POWER has been working in this general direction for many years by careful planning of headlines, boxing off chunks of pertinent text, designing illustrations for fast reader absorption. This new move merely carries the plan one step farther. Do you like it?

The report itself is a fine example of top teamwork between POWER staffers and equipment makers. Jim O'Connor, Ty Hicks, Althea Thornton and Charlie Marschalek, plus many of the country's top motor engineers, funneled their thinking into this timely project.

CYLINDER LINERS, chrome-plated to cut wear, solve many an industrial headache. To get the facts we asked Russ Pyles, VP and Chief Engr, Van Der Horst Corp for his thinking, *p 132.*

Background? After George Washington and Temple U, Russ had a spell with the Air Corps and 7 years ('22 to '29) with NACA at Langley Field. Then, focusing his sights on diesel and gas engines, Russ worked for Westinghouse, Chicago Pneumatic, Clark Bros, and since 1942, with Van Der Horst.

Russell Pyles

SELECTING MEN for plant maintenance, *see p 117,* is but one of Les Clover's specialties as manager of plant engrg and maintenance for GE Realty Corp.

After taking an EE at U of Nevada, Clover tackled the GE test program. His talents leaned toward motor design till key spot as plant engineer beckoned at the Lynn Works in 1948.

Now Clover keeps a close over-all watch on steam, electric, water supplies plus air pollution and the growing problem of industrial waste treatment.

Leslie E Clover

with Power readers...

KEEP MARMY BELOW DECKS

After reading the February issue I'd think Marmy would be ashamed to show his face because of his slanderous attack on the U.S. Navy. I have worked with many Navy officers and they know their engineering. So to see high-ranking officers insulted by Marmy with a bowler hat on (and smoking hemp in their midst) is unthinkable.

We hope POWER editors will see the error of his ways before it is too late. Don't follow in the wake of that derelict Marmy, bound for the Sargasso Sea.

H BRONSTORPH
Bronstorph's Industries Ltd
Kingston, Jamaica, B W I

EDITOR'S NOTE: We too have a high regard for the engineering personnel of the U.S. Navy. But I think we will all admit that in any large group there is an occasional individual who does not match up to the standard. This story was based on an actual incident with but minor modification. It is at least a fair account of one Navy man who grabbed hold of a problem the wrong way.

B&W Cyclone Furnace

a growing factor in the

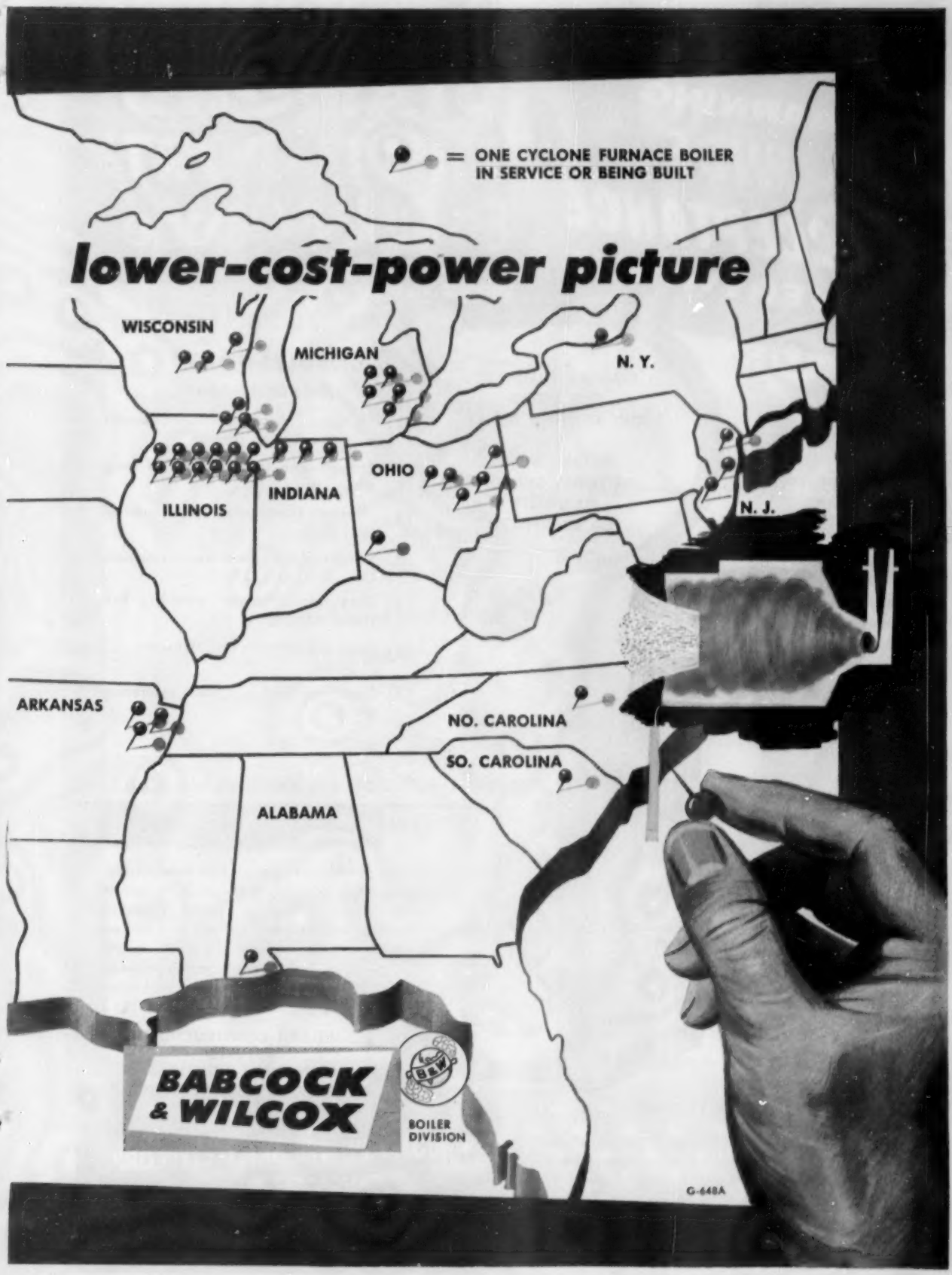
Cost-saving advantages vital to power plant operators are responsible for the mounting acceptance of the Cyclone Furnace. Each represents an important advance in the relentless search of power engineers and designers for more efficient ways to further lower the cost of generating steam for power.

The Cyclone Furnace—

- **Reduces atmospheric pollution to extremely low levels**
- **Simplifies ash handling and disposal**
- **Burns fuel with greater efficiency**
- **Provides greater fuel flexibility with attendant lower costs**
- **Reduces overall first cost**
- **Increases safety by simplifying operation**
- **Reduces maintenance**
- **Increases availability**

Originally designed and developed to burn more efficiently a wide range of coals, as well as oil and gas, the Cyclone Furnace is now being installed in areas where factors other than fuel are prime contributors to higher power generating costs. For whatever the problems — fuel, fly-ash, availability, cost, maintenance — the Cyclone Furnace contributes directly and substantially toward solving them.

With its revolutionary approach to the entire process of preparing and burning fuel, the B&W Cyclone Furnace offers such a simplification of initial design and increased facility in everyday operation, that the overall cost of producing power is greatly benefited. Let us discuss with you the various cost-saving advantages of the Cyclone Furnace for your operation. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.


= ONE CYCLONE FURNACE BOILER IN SERVICE OR BEING BUILT
lower-cost-power picture
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N. Y.
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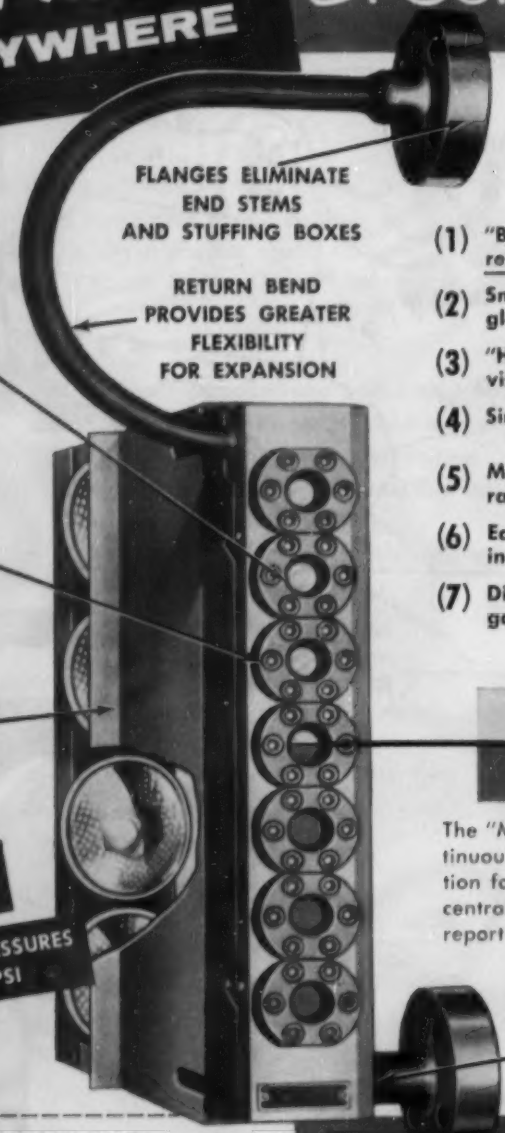
EARNING WIDE ACCEPTANCE EVERYWHERE

DIAMOND "MULTI-PORT"® Bi-Color Gauge



SMALL ROUND INDIVIDUAL PIECES OF MICA AND GLASS

PORT PARTS REPLACED WITHOUT REMOVING GAUGE FROM BOILER

"HI-LITE" ILLUMINATOR

FLANGES ELIMINATE END STEMS AND STUFFING BOXES

RETURN BEND PROVIDES GREATER FLEXIBILITY FOR EXPANSION

FOR BOTH NEW AND OLD BOILERS

FOR BOILER PRESSURES TO 3000 PSI

"MULTI-PORT" Advantages:

(1) "Bi-Color" principle shows steam red and water green

(2) Small round ports instead of long glass strips

(3) "Hi-Lite" Illuminator for improved visibility

(4) Simplified high-pressure construction

(5) Maximum thermal stability for rapid starting

(6) Easy, inexpensive maintenance . . . in place

(7) Direct reading . . . basic reference gauge

STEAM SHOWS RED

WATER SHOWS GREEN

The "Multi-Port" gauge has been in continuous successful high pressure operation for more than two years in leading central station plants. Users everywhere report excellent readability and substantial savings in gauge maintenance costs. For additional information, write for Bulletin 1174.

WELDED CONSTRUCTION ASSURES PERMANENT TIGHTNESS

7211

SEND TODAY

DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO

Please send me without obligation a copy of new Bulletin No. 1174 explaining the advantages of the Diamond "MULTI-PORT" Bi-Color Gauge.

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COMPANY_____

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DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO
Diamond Specialty Limited—Windsor, Ontario

Boilers with 95%+ Availability Are Not Uncommon Today . . . even those burning the poorer grades of coal and oil fuels. A very important factor in this high availability is the type of boiler cleaning system installed. Modern mechanized equipment, automatically controlled, provides uniform and effective cleaning of all surfaces on a scheduled basis. Many existing boilers with much lower availability resulting from surface and gas passage fouling can be improved greatly by a modest investment in modern DIAMOND cleaning equipment.

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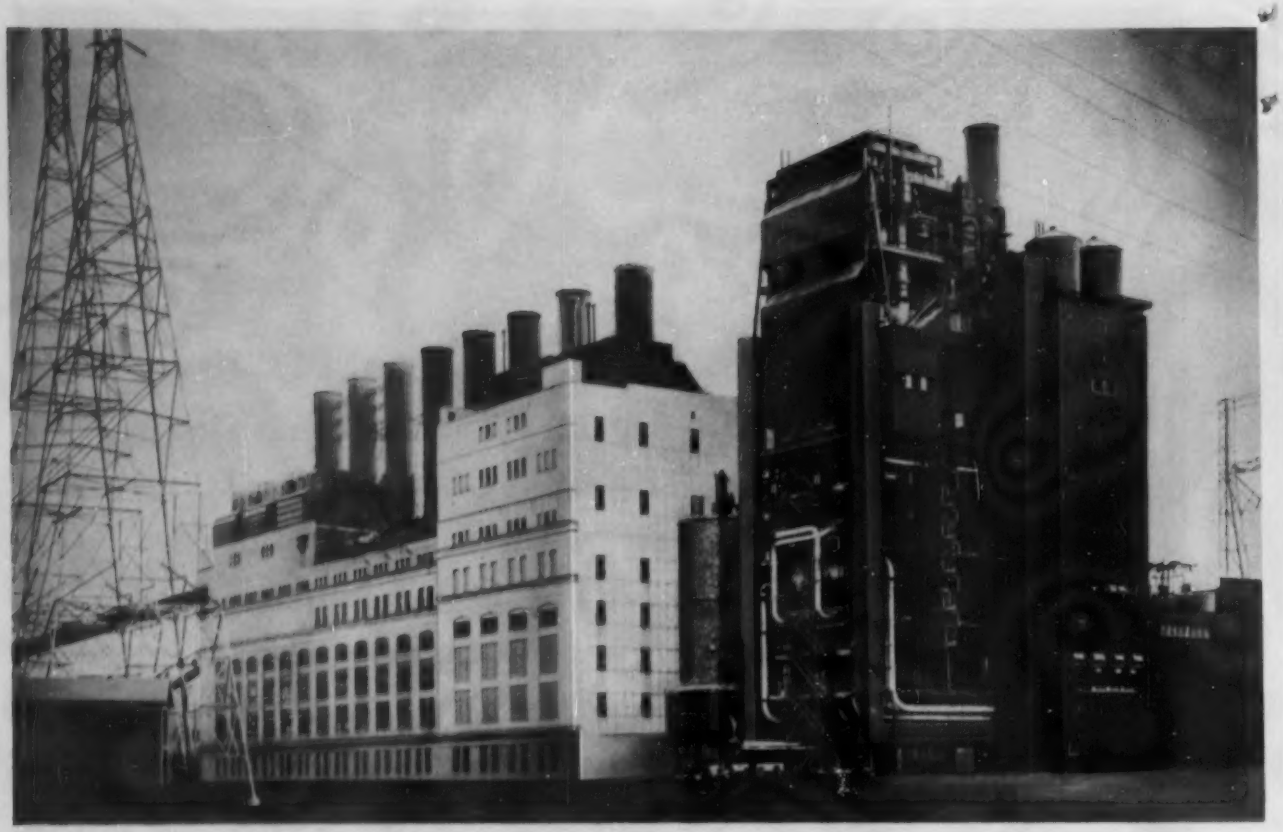
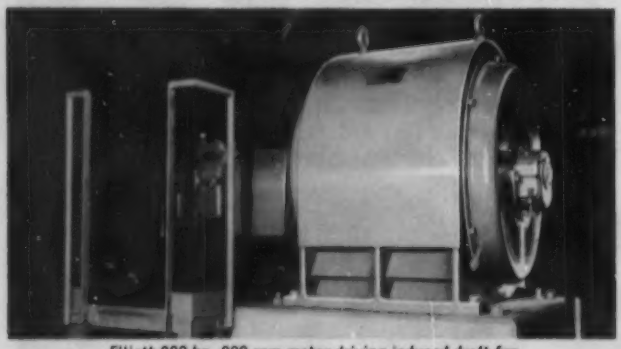
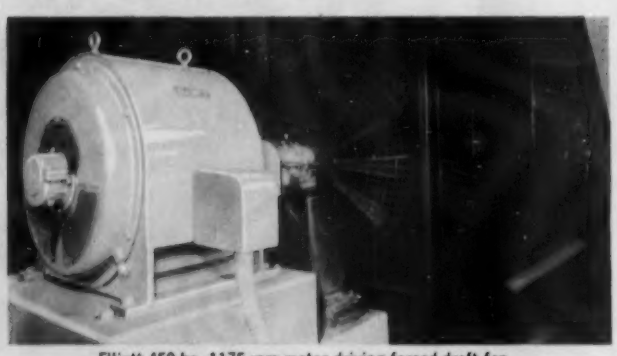


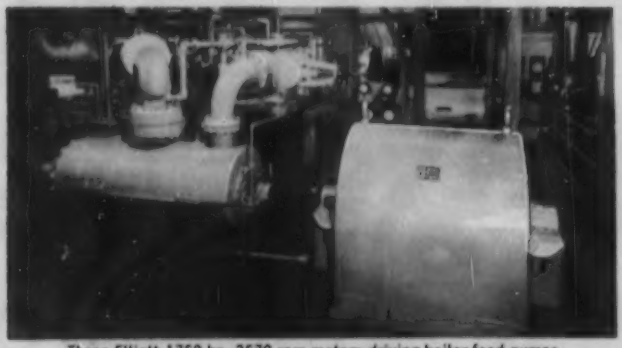
ELLIOTT equipment on the job



Elliott 800-hp, 890-rpm motor driving induced-draft fan.



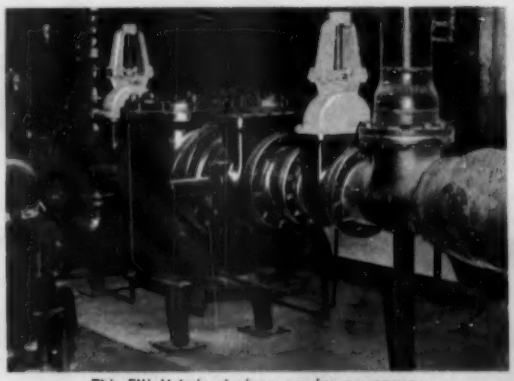
Elliott 450-hp, 1175-rpm motor driving forced-draft fan.



Three Elliott 1750-hp, 3570-rpm motors driving boiler-feed pumps.

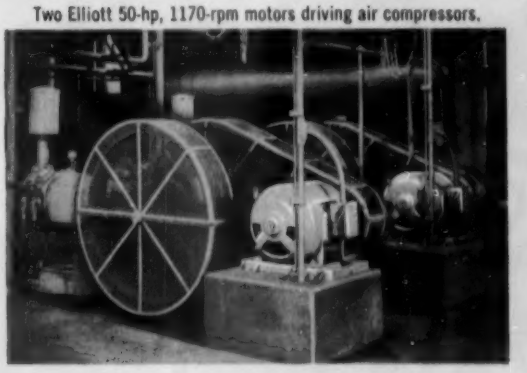
An Elliott 200-hp, 590-rpm motor driving pulverizer. Behind it is an Elliott 250-hp, 177-rpm motor driving primary air fan.

Elliott deaerating feedwater heater, rated 1,000,000 lb per hr, is installed outdoors.



This Elliott twin strainer, serving emergency fire water system, is also installed outdoors.

Two Elliott 50-hp, 1170-rpm motors driving air compressors.



Springdale Station expands with new "outdoor" unit

throughout modern addition!

● West Penn Power Company's Springdale Station has been steadily growing since it first went on the line in 1920. Since that time, new generating units have been added four times and the station has now been brought up to 450,000 kw to serve the growing Western Pennsylvania area. This latest addition—Unit Number Eight—has a capability of 140,000 kw and is an independent unit of semi-outdoor type construction. As is the case with the older units, Elliott equipment is found throughout the new addition. The deaerating heater, evaporator preheaters, twin strainers, and motors driving auxiliaries such as boiler-feed pumps, forced- and induced-draft fans, pulverizers and compressors all bear the Elliott nameplate.

Elliott has been building power equipment for more than half a century. If expansion or modernization is in your picture today or tomorrow, it will pay you to investigate this equipment. Check with your Elliott District Office or write Elliott Company, Jeannette, Pa.

ELLIOTT Company

QS-1

How to Cut

FORMULA for Cutting Production Costs

(BAILEY Design) + (BAILEY Engineering) + (BAILEY Service)

= GREATER SAVINGS PER FUEL DOLLAR

At the heating plant of Lincoln Electric Co., Euclid, Ohio Bailey Control helps to cut operating costs by:

1. Controlling the rate of combustion in two spreader stoker-fired hot water boilers to maintain the desired temperature of outlet water.

2. Controlling fuel-air ratio at each boiler by means of a unique Btu-Air Flow meter which maintains most economical use of fuel.

3. Controlling quantity of water by-passed around boilers, thus tempering water supplied for heating in accordance with changes in outside temperature.

Operating Cost

★ When your plant is operating at peak efficiency, unit production costs are low. But outages of any kind upset the balance. As efficiency drops, and/or outages occur, overhead costs impose an increasing burden—bring on dollar losses that can't be recovered.

That's why you can use Bailey Co-ordinated Control Systems to advantage. Here are three reasons why Bailey systems are the best you can buy:

1. Complete Range of Equipment—fully co-ordinated

You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control *systems*.

2. Engineering Service—backed by experience

No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement, and automatic control.

3. Direct Sales-Service—conveniently located near you

Bailey Meter Company's sales service engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

For lower operating cost—for more power per fuel dollar, less outage, and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More Power To You!"

A-119A-2

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METER COMPANY
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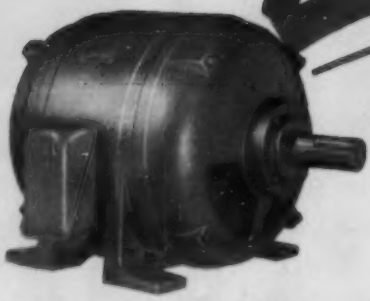
Complete Controls for Steam Plants

BAILEY METERS
Controls for
COMBUSTION
FEED WATER
TEMPERATURE
PRESSURE
LIQUID LEVEL
FEED PUMPS

Choose The Exact

Drip-proof motors — NEMA frames through 445 — with cast-iron frames, double-shielded bearings, provision for in-service lubrication, die-cast rotor cages. Ventilation is end-to-center, with well protected discharge. Ball bearings fully protected from air-borne dirt by bolted-on inside cap and labyrinth sealed housing. Also sleeve bearings, frames 365 through 445. *Bulletin 51B6210*



Drip-proof and splash-proof — above NEMA 504 frame to 800 hp at 3600 rpm — have cast steel yoke heads with integral mounting feet and heavy continuous welded drip covers. Available with solid or split sleeve bearings or anti-friction bearings. *Bulletin 51B7693.*

Totally-enclosed fan-cooled and explosion-proof — NEMA range — with double-shielded ball bearings, provision for in-service lubrication; sleeve bearings available in larger sizes. Special non-clogging design. Explosion-proof UL approved for Class I, Group D and Class II, Groups E, F and G service. *Bulletins 51B7225, 51B7286.*

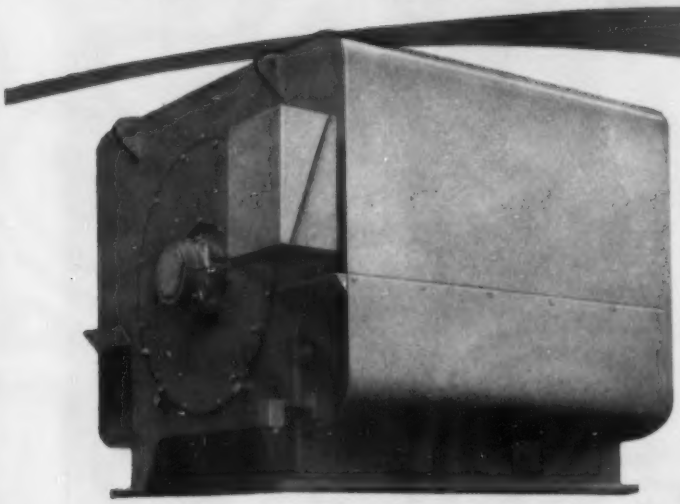
Tube-type TEFC and explosion-proof — to 4000 hp. Frame is surrounded by tubes. Internal fans circulate inside air around tubes; external fan drives outside air through tubes to dissipate heat. This operation-proved arrangement permits full, balanced internal air circulation. *Bulletins 51B7149, 51B7150.*

Two-pole motors for quiet boiler-feed pump drives and similar service available in special design in sizes 900 hp and larger. High level air intake and discharge make it easy to meet power plant housekeeping requirements. Lower area of motor is completely enclosed to keep moisture out during hosing-down operations. *Bulletin 05R8123.*

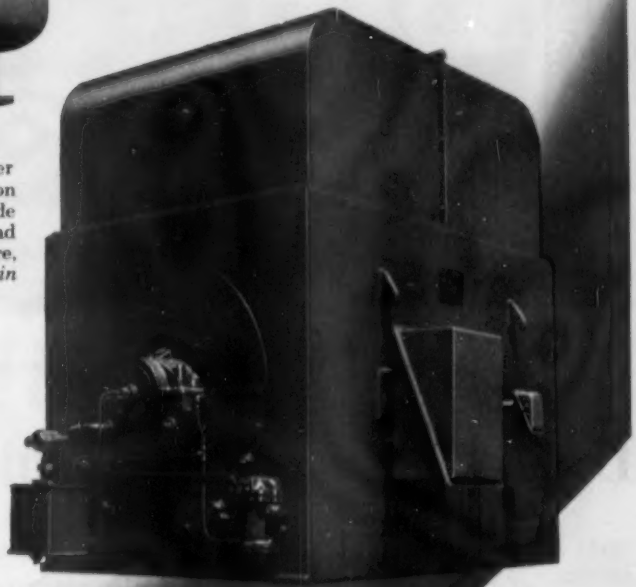
Drip-proof and splash-proof — 60 hp at 300 rpm to 3000 hp at 1800 rpm. Sleeve bearings standard, but anti-friction bearings may be had where speed and application are suitable. Capsule-type bearing housings protect bearings from contamination when end shields are removed for cleaning or inspection. *Bulletin 05B7542*

ALLIS-

Motor You Need

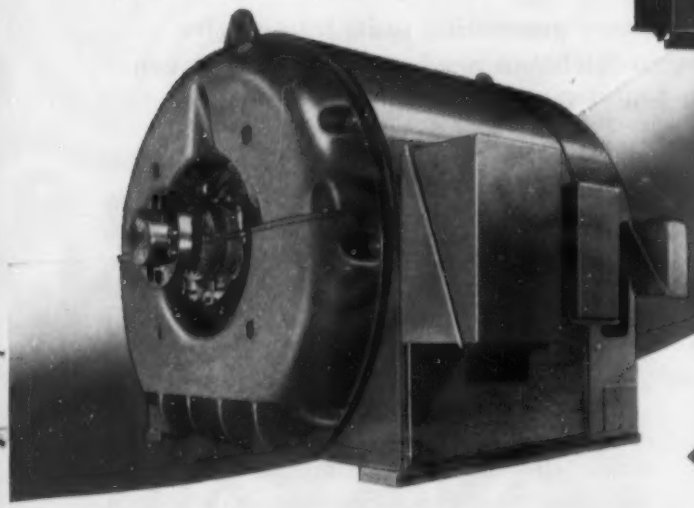


Synchronous and wound-rotor. Medium range end-shield bearing design shown, smaller and larger ratings in similar and pedestal bearing designs. End-shield bearing design shown features welded steel plate frame and cast-iron end shields. Sleeve bearings are standard and are mounted in capsule-type housings which protect bearings when upper halves of end shields are removed. *Bulletin 05R8183*



Water-cooled design, with air-to-water heat exchanger, is available in large induction and synchronous motors. Advantages include total enclosure of operating parts, low sound level, uniform motor operating temperature, and removal of heat from motor room. *Bulletin 05B7682.*

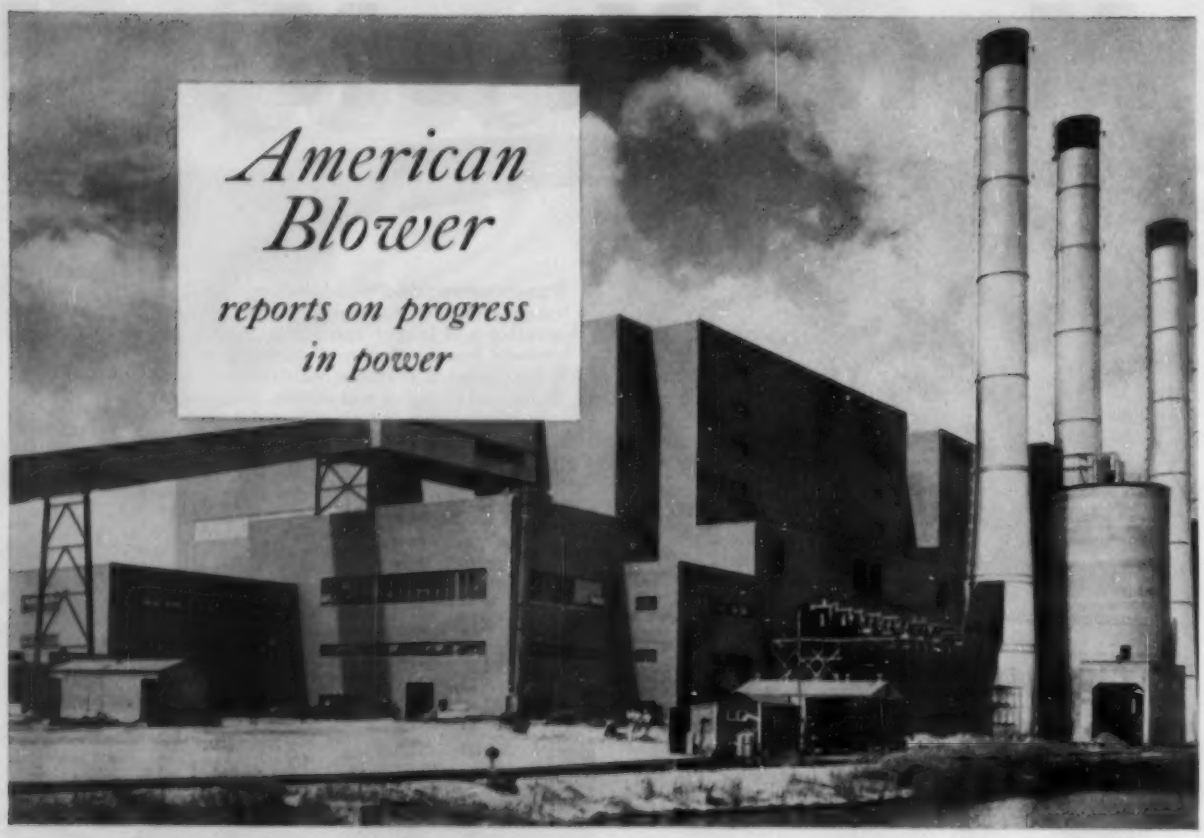
Weather-protected — designed to give trouble-free outdoor operation in all climates. Rain, fog, snow, blowing dust, and other adverse weather conditions will not harm this motor. Available in full range of ratings required for major auxiliary drives, including boiler feed pumps. *Bulletin 05R7874.*



NO MATTER WHAT your power plant application, Allis-Chalmers makes a horizontal or vertical motor specifically suited to that application. And wide experience with power plant drives enables Allis-Chalmers representatives and application engineers to offer invaluable assistance to you and your consulting engineers when planning new facilities. Do not hesitate to call your nearby A-C district office whenever you need information or assistance. Or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-4765

A-C ALLIS-CHALMERS

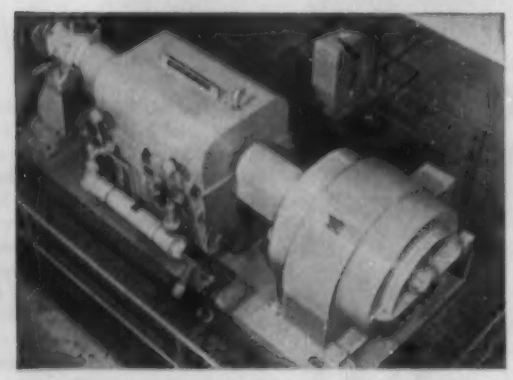
CHALMERS



St. Clair Power Plant is one of five stations in The Detroit Edison Company system. It was dedicated October 21, 1954, 75 years after Thomas A. Edison perfected the first practical light bulb. A sixth power station is under construction.

Detroit Edison system demand reaches

The Detroit Edison Company puts new generating units into service at St. Clair plant to meet Southeastern Michigan needs; relies on American Blower Gyrol Fluid Drives for boiler feed pump and fan control.

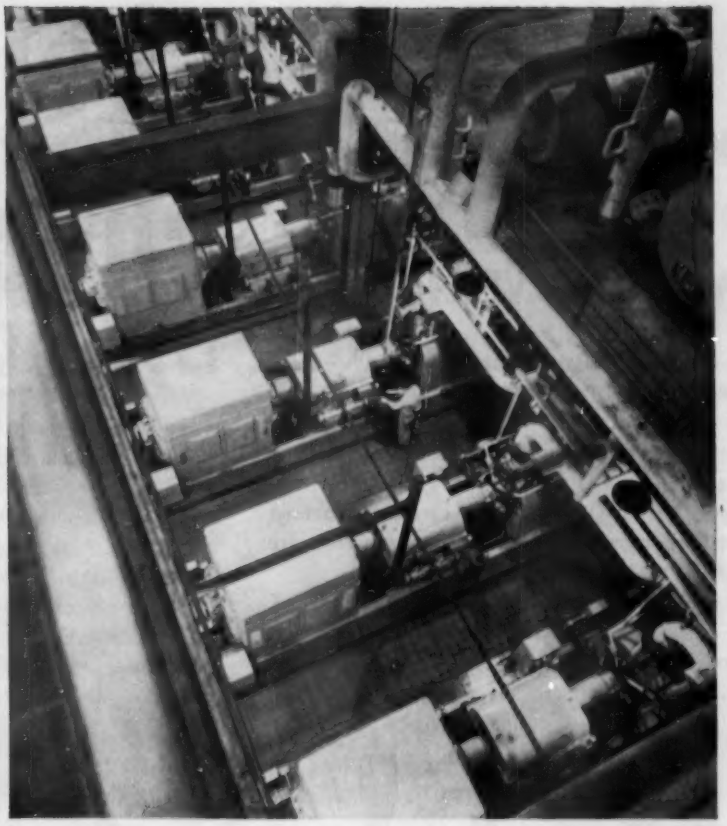


American Blower, Type VS, Class 4, Gyrol Fluid Drive unit drives induced draft fan on one of four boilers in Edison's St. Clair plant. 16 units deliver 15,600 h.p. to the mechanical draft fans.

By year's end, 1954, The Detroit Edison Company electric power system had developed a total capability of 2,535,000 kilowatts. Two new turbine-generators at Edison's St. Clair Power Plant went into operation, boosting the system's capability 312,500 kilowatts.

The boost was timely. A large increase in domestic customers, and very substantial additions of new industrial loads in Southeastern Michigan, had placed new power demands on the Edison system — 214,000 kilowatts more than the peak load for 1953.

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS •



American Blower Gyrol Fluid Drives provide adjustable speed control for the boiler feed pumps at St. Clair station. Shown are six of twelve. Total capacity: 20,400 h.p.

all-time peak of 2,236,000 kilowatts

From concrete to kilowatts

The new St. Clair Power Plant serves Michigan's southeast area, with a total guaranteed capacity of 625,000 kilowatts. Construction of the plant began in February, 1951, and it now houses four giant turbine-generators, each with a 156,250 kilowatt capability. The first and second machines began operating in the fall of 1953; the third in June, 1954, and the fourth in October of that year.

Four boilers produce steam for the turbine-generators. Each unit has three combination boiler feed and heater feed pumps. American Blower Gyrol Fluid Drives are used to ensure smooth, adjustable speed control of the boiler feed pumps.

In its post-war expansion program, The Detroit Edison Company has incorporated American Blower Gyrol Fluid Drives to the extent of nearly 100,000 h.p. At the St. Clair Power Plant, these fluid drives deliver a total of 36,000 h.p. in driving the feed pumps and mechanical draft fans.

Call on American Blower

If you are planning to expand or modernize your facilities, contact your nearest American Blower representative. He can recommend efficient, economical equipment — including Mechanical Draft Fans, Fly Ash Precipitators, Dust Collectors, Heavy Duty Steam Coils, as well as Gyrol Fluid Drives for boiler feed pump and fan control. Call your nearest American Blower Branch Office for full information.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER

KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

it's boiler check-up time!

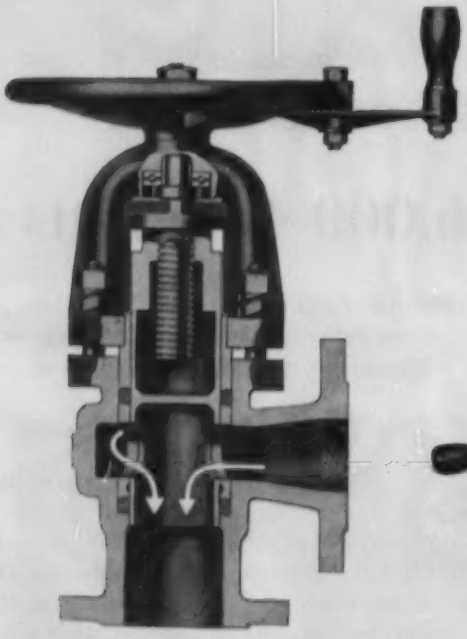
HOW ARE YOUR BLOW-OFF VALVES?

Are they drop-tight? Rugged and dependable? Easy to maintain?

Just as important, do they have all the advantages and up-to-date improvements in materials and design of new YARWAY Blow-Off Valves?

Old YARWAY Blow-Off Valves also can be overhauled and modernized, because all YARWAY improvements are *interchangeable* with parts on earlier models.

Write today for YARWAY Blow-Off Valve CHECK SHEET—also new YARWAY Blow-Off Valve Catalog B-426 (pressures to 400 psi) or B-434 (pressures to 2500 psi).



Yarway Seatless valve for low and medium pressures. Features balanced nitralloy plunger that seals line drop tight—yet permits free, unobstructed flow in blow-down. **Used in over 15,000 boiler plants.**

Yarway Unit Tandem Blow-Off Valve for higher pressures. Combines Yarway Seatless Valve and Yarway Hard-Seat Valve, or two Yarway Hard Seat Valves, in a one-piece forged steel body. For years—the choice of 4 out of 5 high pressure power plants.

YARWAY steam

✓WHAT ABOUT WATER COLUMNS AND GAGES?

Are they in good working order? Are they up-to-date?

Is the water level clearly visible from the operating floor? YARWAY Gages equipped with Type "M" Illuminators make the meniscus "shine like a star"—even under adverse conditions.

Now's the time to install modern YARWAY Water Columns and Gages. Twelve distinct improvements in YARWAY Gages have increased gage life—decreased gage maintenance. Write for latest Catalog WG-1812.

✓HOW ABOUT ADDING NEW REMOTE LEVEL INDICATORS?

Remote readings of boiler water level at any spot in the plant are a recognized convenience—and easy with new "Wide Vision" YARWAY Remote Liquid Level Indicators.

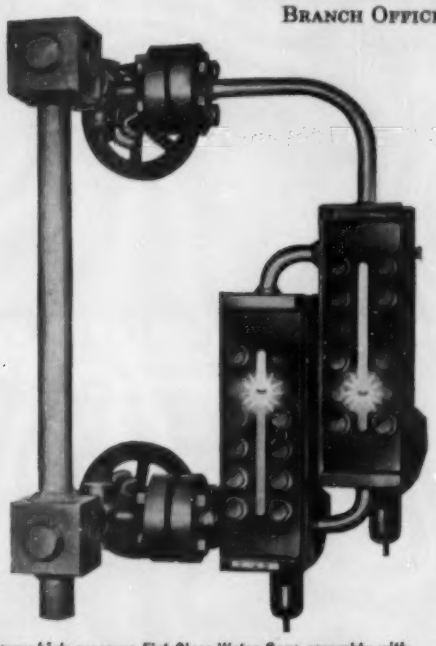
Because the indicating mechanism is operated by the boiler water itself, response is always instant, readings always accurate.

YARWAY Hi-Lo Graph Recorder not only gives remote indication but also a 24-hour recording of water levels.

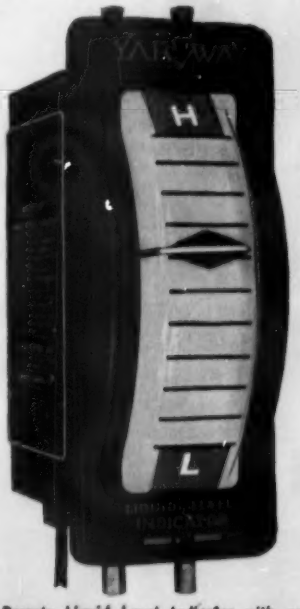
YARWAY Remote Indicators and Recorders can also be supplemented with Remote Hi-Lo Alarm Signals—light or horn.

Write for Catalog WG-1823.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES



Yarway high pressure Flat-Glass Water Gage assembly with tie-bar type circulating water column. Note separated design, expansion loops, flanged connections and Type "M" Illuminators. Other columns and gages for lower pressures.

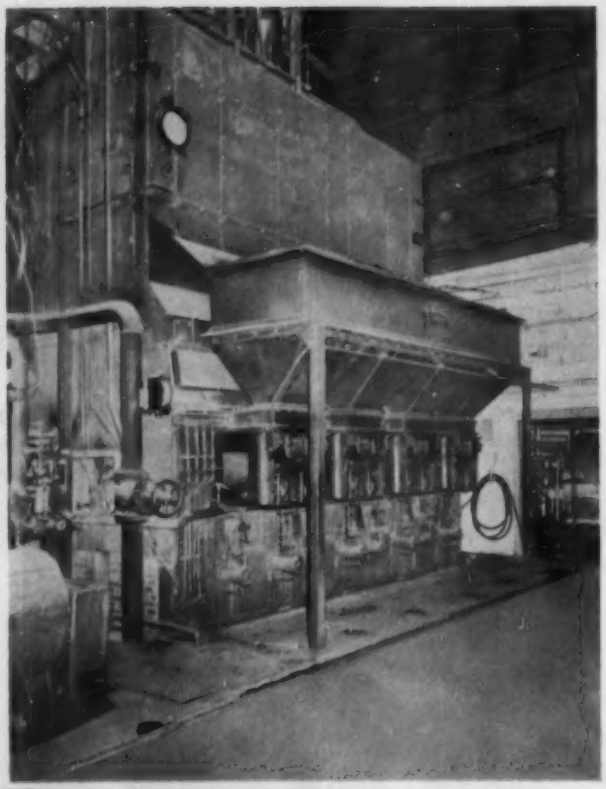


Yarway Remote Liquid Level Indicator with new "wide vision" face. Manometric type with automatic temperature compensation where required. Over 10,000 used throughout industry.

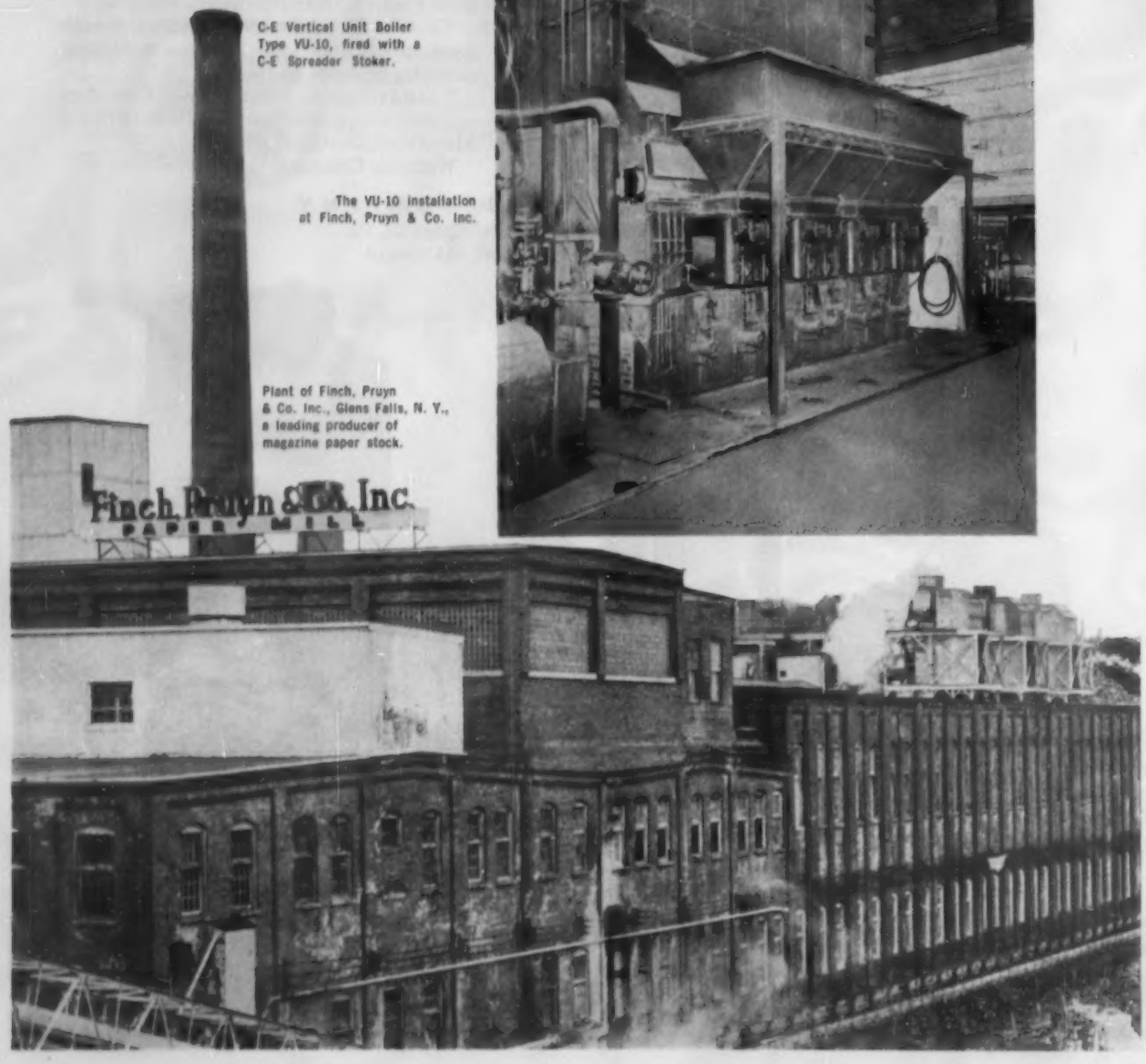
plant equipment

They cut steam costs 20% with a—

C-E Vertical Unit Boiler Type VU-10, fired with a C-E Spreader Stoker.



The VU-10 installation at Finch, Pruyn & Co. Inc.



Plant of Finch, Pruyn & Co. Inc., Glens Falls, N. Y., a leading producer of magazine paper stock.

—C-E VERTICAL UNIT BOILER

When more steam was needed at the Glens Falls, N. Y. plant of Finch Pruyn and Co., Inc., they bought a C-E Vertical Unit Boiler, Type VU-10, fired with a C-E Spreader Stoker.

For over a year the VU-10 has been operating continuously on a six-day, three-shift basis. And during that time boiler performance has consistently exceeded guarantees and the plant's steam cost has decreased 20%.

What does Finch Pruyn think of its new VU-10? Here are some comments made by N. G. McLean, Chief Engineer, and L. J. Dolhof, Utility Engineer:

Delivery: "The delivery and installation of the new boiler established a record for speed . . . "

Operation: " . . . a clean operating boiler that affords us a steady source of steam."
" . . . this has been a very satisfactory job and doing business with you has been a pleasure."

Cooperation: "The Combustion Engineering organization cooperated splendidly with us in getting the new boiler on the line."

Such things as simplicity of operation, efficient performance, ease of maintenance and reliability are the four big reasons that account for the comments above – and for the many others like them that we have received.

So, if your steam requirements are between 10,000 and 60,000 pounds per hour, investigate the C-E Vertical Unit Boiler, Type VU-10.

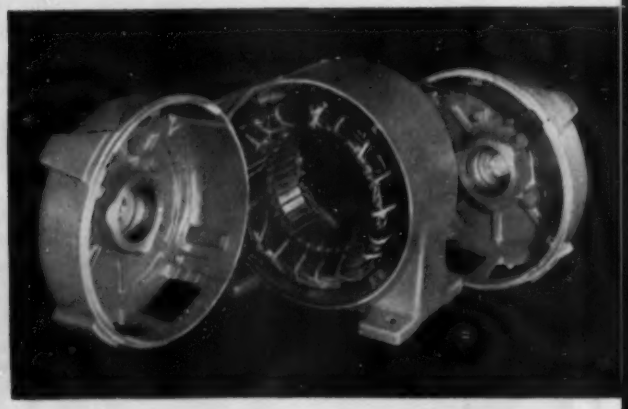
Available for pressures to 475 psi, this unit can be equipped with a superheater (up to 200° F) and whatever heat recovery equipment is desired. Designs are available for coal, oil or gas firing. B-840

COMBUSTION ENGINEERING

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

BOILERS, FUEL BURNING & RELATED EQUIPMENT; PULVERIZERS, AIR SEPARATORS AND FLASH DRYING SYSTEMS; PRESSURE VESSELS; AUTOMATIC WATER HEATERS; SOIL PIPE

MOTOR FACTS ON INDUSTRY'S
MOST-PREFERRED "POWER PACKAGE"



Electrical System Fact: New fortified insulation includes exclusive Bondar, Bondite and Mylar* for greater protection against the toughest operating conditions.

*Du Pont registered trade-mark

FACT:

The new Life-Line A has stronger insulation than any other motor on the market

Meaning what? Simply that the new Westinghouse Life-Line® "A" motor with new fortified insulation can withstand heavier overloads and operate at higher temperatures than any other motor you can buy.

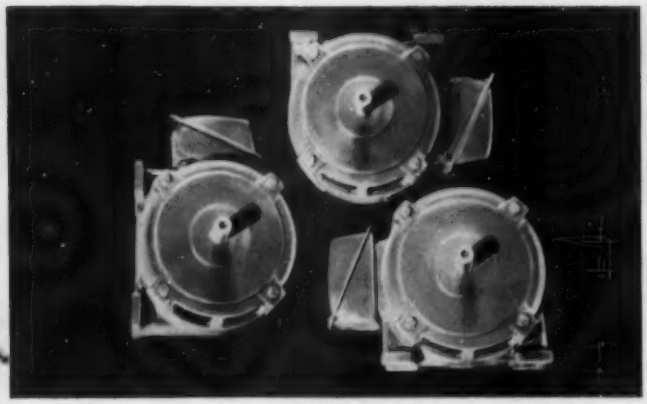
Similar design advances in the mechanical and lubrication systems make Life-Line "A" industry's most preferred motor.

It takes the right combination of *all three systems*—electrical, mechanical and lubrication—to build the best package of power on the market.

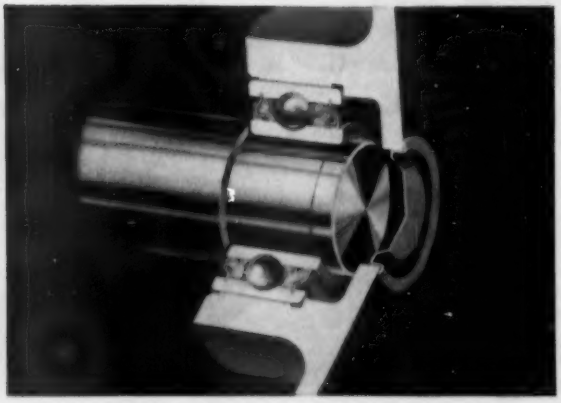
Get all the facts by calling your Westinghouse sales engineer . . .
The Man With The Facts!

J-21877

YOU CAN BE SURE...IF IT'S
Westinghouse



Mechanical System Fact: New cast-iron housing on both drip-proof and totally-enclosed types. Ventilation openings only in end brackets make the motor drip-proof whether mounted on floor, ceiling or wall.



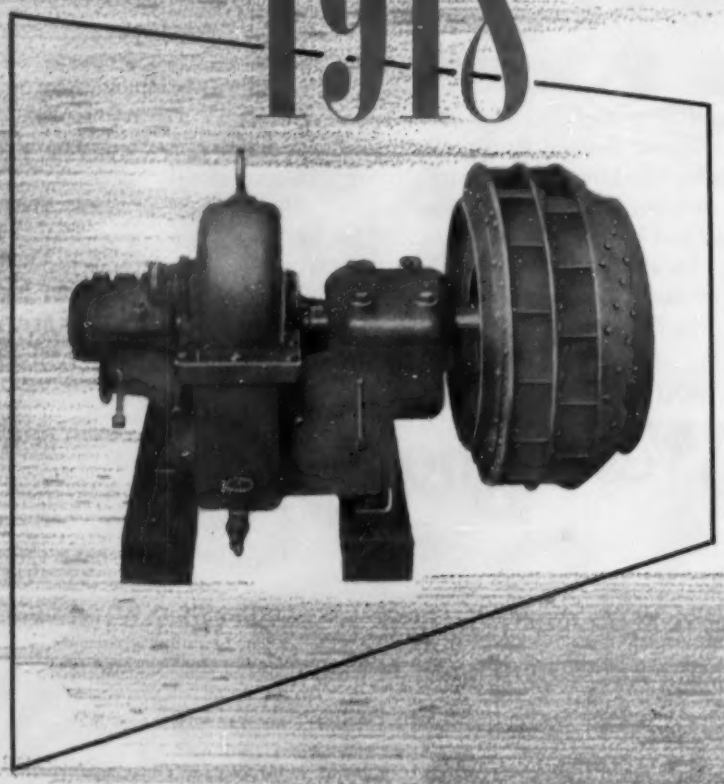
Lubrication System Fact: New "4-way sealed", pre-lubricated bearing eliminates completely the 3 main causes of bearing failure: 1) contamination, 2) over greasing, 3) wrong grease.

Announcing 1918

1918 TYPE OF GREEN AIRFOIL FANS

Typical of the scores of AIRFOIL Type Fans we designed, manufactured, and shipped some 35 years ago. Some of these units are still in service.

These two drawings with dates in the World War I era show details of the Green AIRFOIL Type Fans as designed and manufactured by us in those days.



We use the word 're-opening' purposely for in 1918 at our factory in Beacon and for a few years thereafter we designed, manufactured and shipped many AIRFOIL Type Fans. *The AIRFOIL Type of Fan is not new.* But it has been modernized, refined and improved. Basically, the 1955 fans are not unlike the 1918 units. The blades then and the blades today simulate the design of the airplane wing. Then, as today, this type of blade produces considerably higher mechanical and static efficiencies than other types of blades.

The 1955 Line of Green AIRFOIL Type Draft Fan consists of six (6) different design variations which provide wide latitude in the choice of volume-pressure combination. Conservatively rated—as has always been a Green policy—these fans show exceptionally high static and mechanical operating efficiency.

We are designating our line of AIRFOIL Fans as the GALEX Fans. They really deliver gales of air.

Complete details of the Green AIRFOIL Fans will be sent on request. Our engineers will be glad to discuss your fan requirements if you have any specific questions.

THE RE-OPENING OF THE LINE OF GREEN AIRFOIL TYPE FANS

1955 VERSIONS OF 1918 DESIGNS

1955

1955 VERSION OF AN AIRFOIL TYPE FAN

GREEN THE AIRFOIL TYPE FAN Calex FAN

GREEN

POWER AND PROCESS PLANT EQUIPMENT

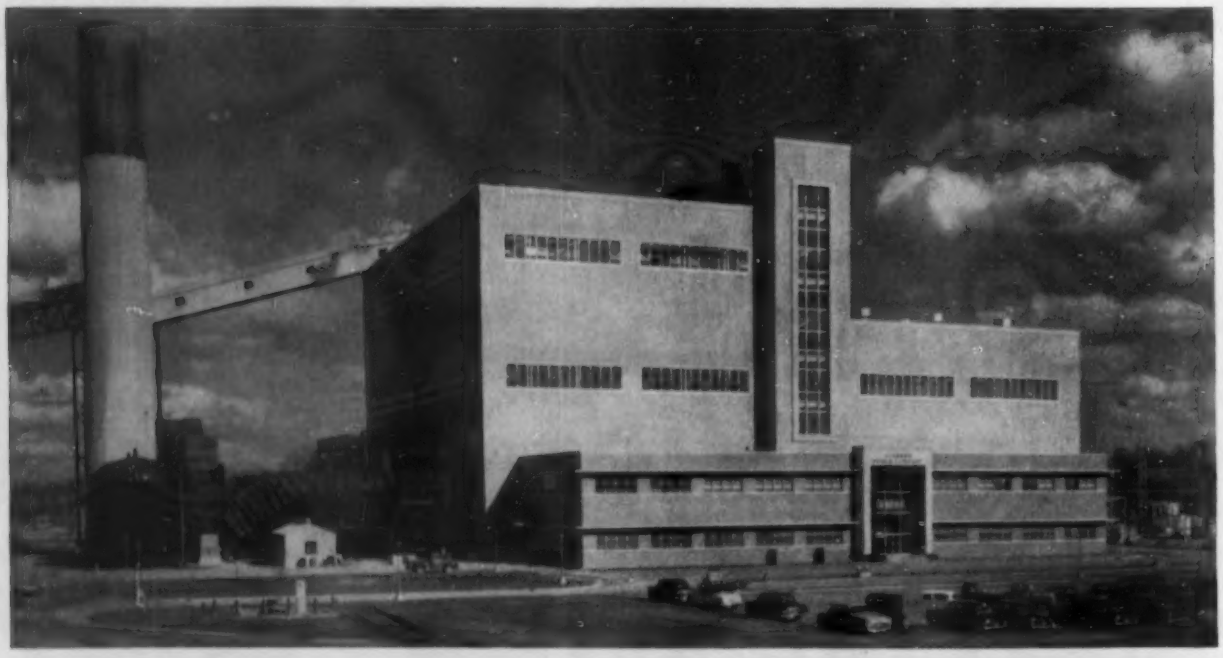
FUEL ECONOMIZER COMPANY

BEACON 3, NEW YORK

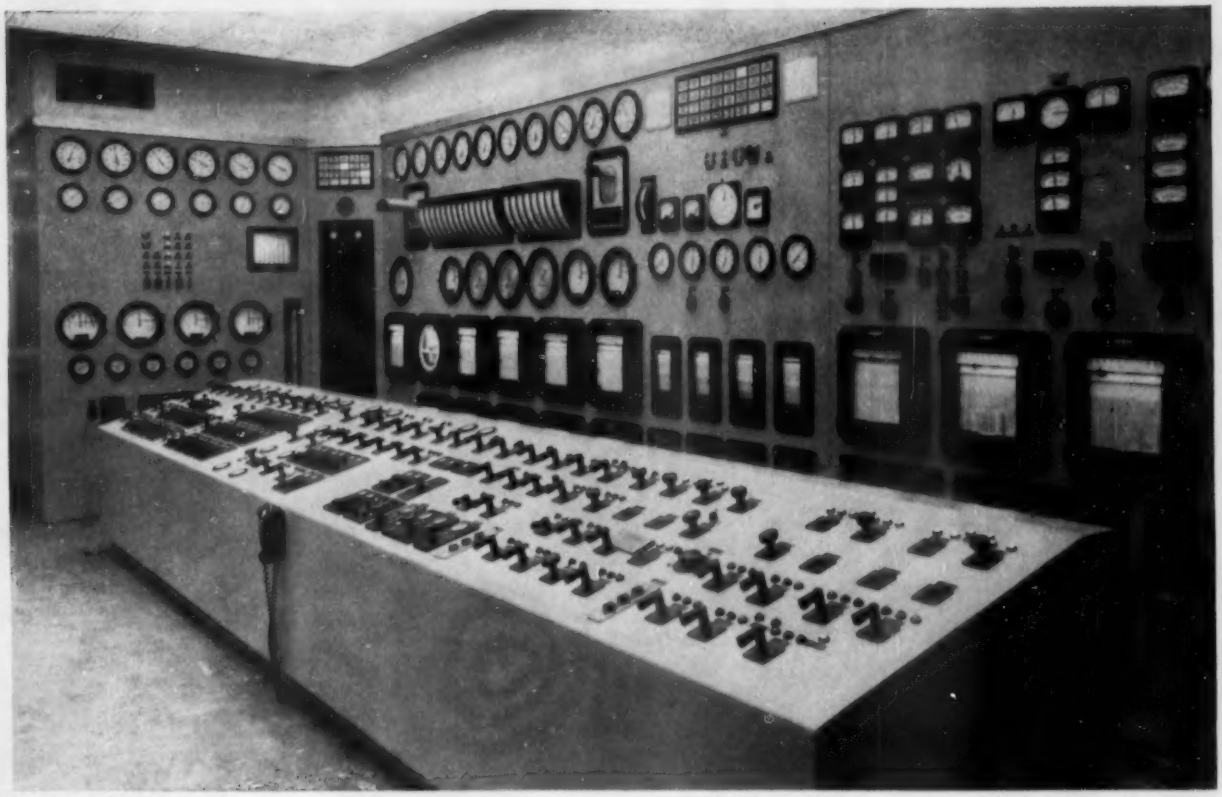
Operating Boilers Electronically at Alabama Power Company's NEW BARRY PLANT

"On the line" since early 1954, the new Barry Steam Plant near Mobile, Alabama adds 250,000 kw to Alabama Power Company's expanding system. Plans provide for the possible enlargement of the plant to 1,000,000 kw capacity.

REPUBLIC



REPUBLIC FLOW METERS CO.



Centralized controls for station service switching, turbines, generators and boilers are in this room. Republic sub-panels on the bench board provide for either automatic or manual control of the boilers.

Automatic Combustion Controls

At the new Barry Steam Plant, two 900,000 lbs. per hour pulverized coal fired boilers operating at 1875 psi and 1000°F. are controlled by a Republic Electronic Master Combustion Control System.

Electronic impulses control pneumatically operated fuel, draft, and feedwater regulators on the boilers. Master control signals are transmitted practically instantaneously, permitting fast control response and close boiler control.

To ensure that both final firing rate and air flow will rapidly and accurately follow changes in steam load, the control system normally follows a dual element master control. This master controls the boiler auxiliaries from a rapid and proportional steam flow function together with a stabilized steam pressure function. Such a system combines the features of derivative control with automatic correction for fuel variation in such a manner that the effects of load swings are minimized almost to the vanishing point. Other control problems such as feedwater control and steam temperature control are simplified by the coordination of boiler auxiliary functions due to this system of combustion control.

Republic boiler feedwater is controlled automatically by a three-element feedwater control. To prevent heat damage to feedwater pumps during low flows, a Republic pump by-pass system has been installed. It automatically maintains a minimum flow of 125 gpm through each pump (two pumps per boiler) returning by-passed water to the deaerating heater storage tank.

Final efficiency tests recently completed at the Barry plant indicate the expected plant heat rate has been fully realized. There are Republic Automatic Combustion Control Systems — electronic or pneumatic — for all sizes and types of boilers, all methods of fuel firing and for any arrangement of draft equipment. For full details, write today.

2240 Diversey Parkway • Chicago 47, Illinois

How exhaust heat from a G-E Gas Turbine can cut your plant operating costs

NEW CYCLE CAN RESULT IN EFFICIENCY AS HIGH AS 70%

With more than 675,000 hours of successful commercial operation to their credit, General Electric gas turbines now offer power engineers this *new* formula for lowering processing costs:

Use the gas turbine to drive a generator of up to 16,000 kw or mechanical equipment up to 21,500 hp; pass the exhaust heat through a heat-recovery boiler to supply plant process steam up to 95,000 lbs. per hour. (If more process steam is required, use supplementary fuel firing to obtain up to 270,000 lbs. per hour.)

The resulting over-all efficiency may be as high as 70%!

Operating costs are low because gas turbines offer not only fuel savings resulting from high-cycle efficiency, but also economies in water, lubricating oil, maintenance, and manpower requirements. In addition, modified low-cost residual fuel oil can be burned in G-E gas turbines to provide even greater economy.

Initial costs are low too. Only small buildings and simple foundations are needed to install a G-E gas turbine; a new self-contained base houses most related auxiliary equipment.

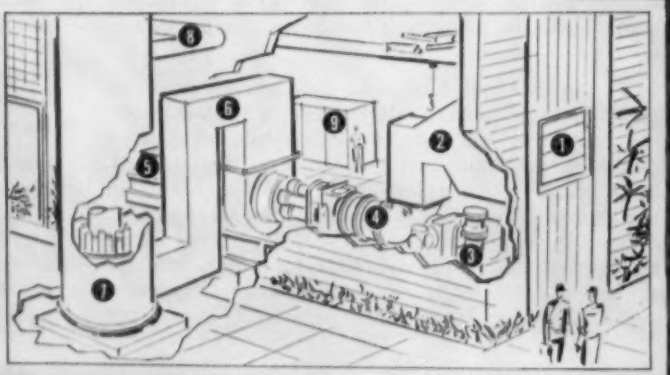
Your company may well profit from using a G-E gas turbine, and General Electric will be happy to work out an economic study with you.

For more information contact your nearest G-E Apparatus Sales Office or write for Bulletin GEA-5516B. General Electric Company, Section 261-16, Schenectady 5, New York.

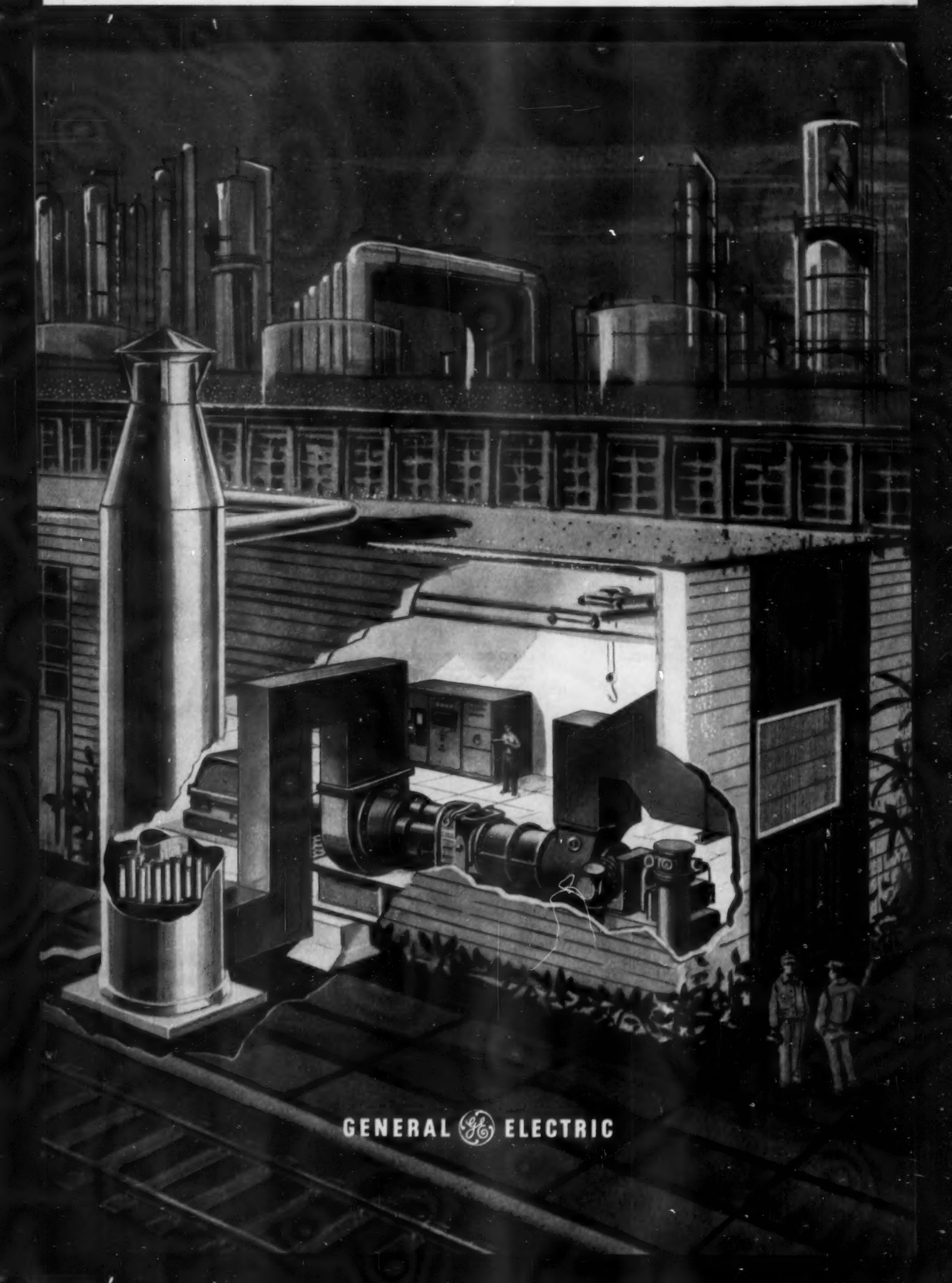
Progress Is Our Most Important Product

GENERAL ELECTRIC

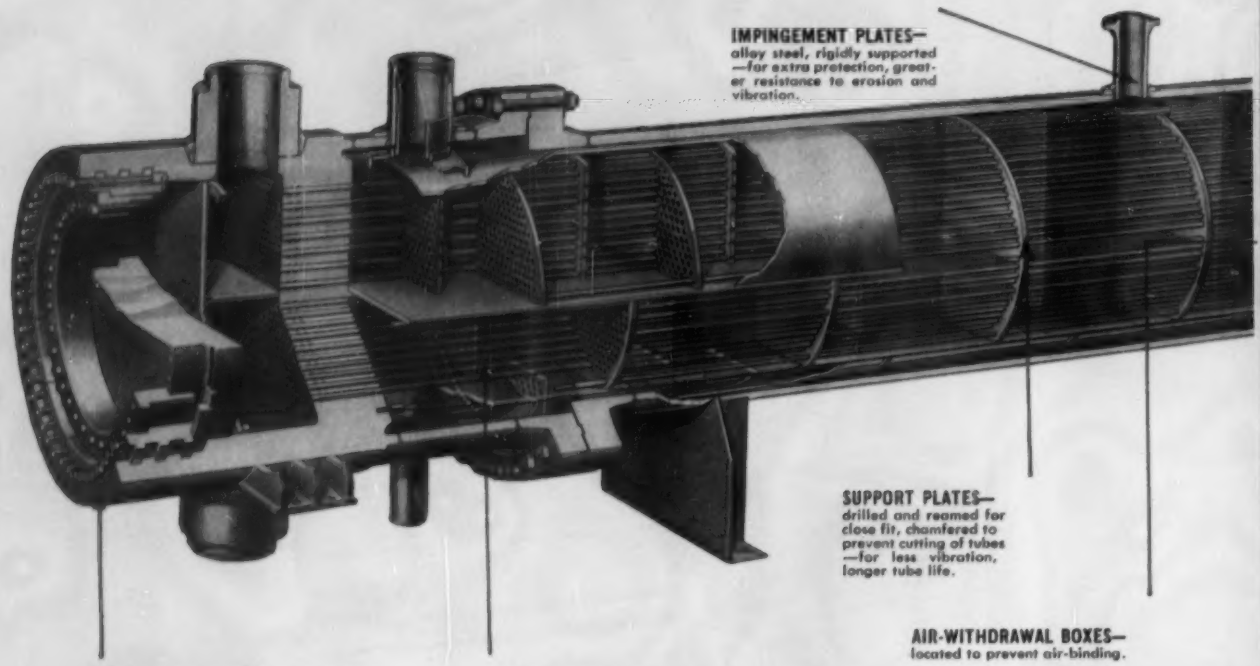
TREMENDOUS SAVINGS in installed cost have been made possible by this new gas turbine base mounting, recently developed by G-E engineers. Serving as a rigid foundation, it also houses most of the auxiliary equipment.



CHIEF COMPONENTS are: 1. Filter and/or air washer, 2. inlet duct, 3. starting unit device, 4. gas turbine, 5. gas compressor or driven equipment, 6. exhaust duct, 7. exhaust heat recovery boiler, 8. steam to process, 9. control unit.


GENERAL ELECTRIC

For Modern Power Plants...


IMPINGEMENT PLATES—
alloy steel, rigidly supported —for extra protection, greater resistance to erosion and vibration.
SUPPORT PLATES—
drilled and reamed for close fit, chamfered to prevent cutting of tubes —for less vibration, longer tube life.
AIR-WITHDRAWAL BOXES—
located to prevent air-binding.
SMALLER SCREW FASTENINGS—
to set in water box closure.
LARGE ESCAPE AREA—
plus excellent steam distribution—for increased operating efficiency.

HIGH-CAPACITY HEAT TRANSFER

ALCO'S New . . . Improved Feedwater Heater . . . and Flex-Tube Evaporator

Together they mean new efficiency and performance . . . greater savings for you.

Listed are but a few of the many new operating and installation advantages you get when you specify either or both of these dependable ALCO items.

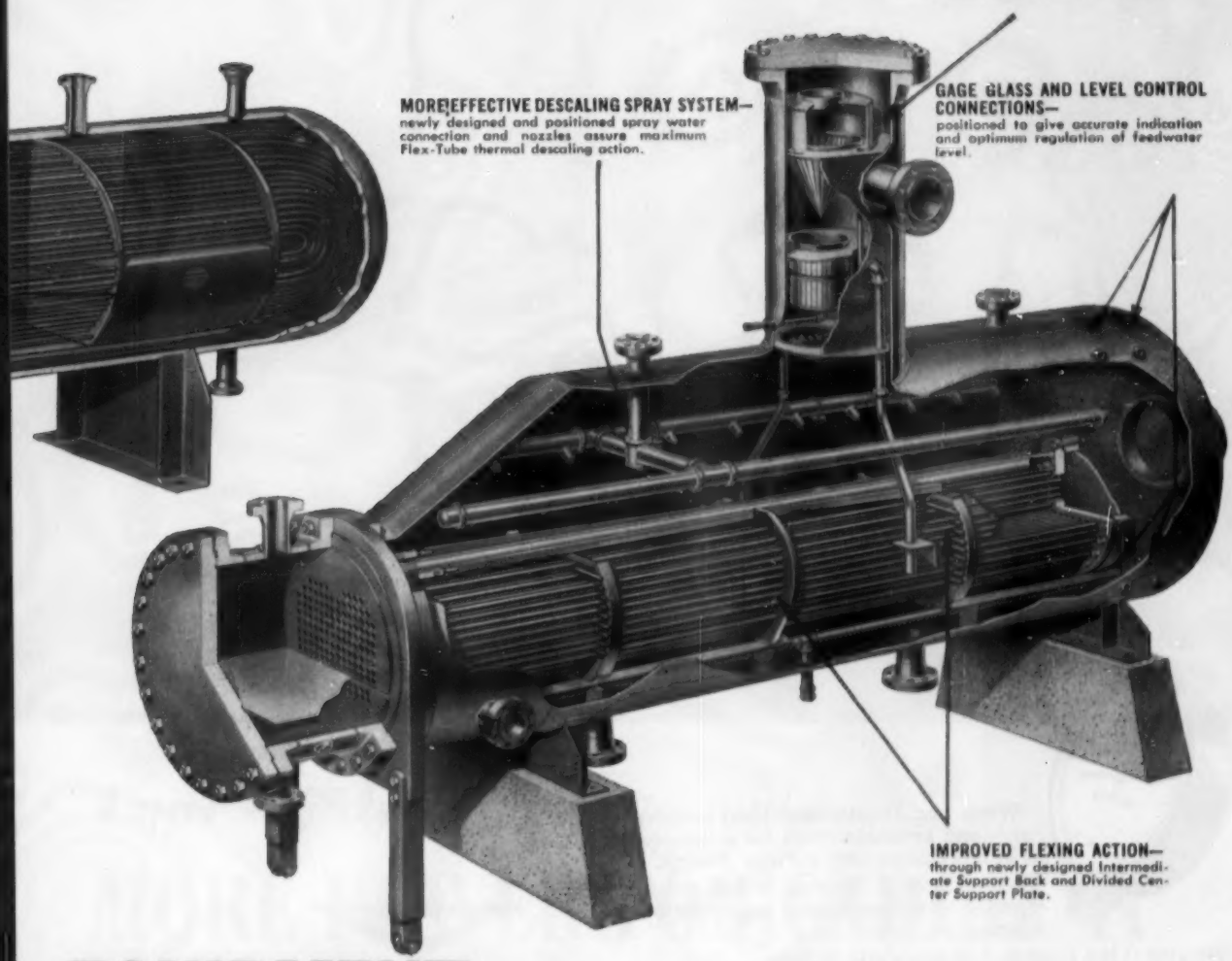
ALCO Feedwater Heaters and Flex-Tube Evaporators are built to ASME Code specifications.

They're custom-engineered to meet your individual requirements and backed by ALCO's more than 25 years experience in supplying equipment for over 100 power installations across the nation. Call your ALCO representative for full particulars about these units or about specialized equipment for atomic energy installations—you also may write to Box 1065, Schenectady, New York.

SUPERIOR VAPOR SEPARATOR SYSTEM—
made possible through a new 3-stage dryer, scrubber and purifier assembly.

MORE EFFECTIVE DESCALING SPRAY SYSTEM—
newly designed and positioned spray water connection and nozzles assure maximum Flex-Tube thermal descaling action.

GAGE GLASS AND LEVEL CONTROL CONNECTIONS—
positioned to give accurate indication and optimum regulation of feedwater level.



IMPROVED FLEXING ACTION—
through newly designed Intermediate Support Back and Divided Center Support Plate.

EQUIPMENT

Consult your ALCO Sales and Engineering Representative:

ATLANTA, Ga.	490 Glenn St., S. W.
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ALCO PRODUCTS

ALCO PRODUCTS, INCORPORATED

formerly AMERICAN LOCOMOTIVE COMPANY

When you need more AIR

When you require additional compressed air—and available space for a compressor is at a premium—try a Fuller Rotary.

Because it is a Rotary, it has twice the capacity of a comparative horizontal-belted reciprocating unit.

Because it is a Rotary, it is singularly lacking in vibration and requires only a nominal foundation.

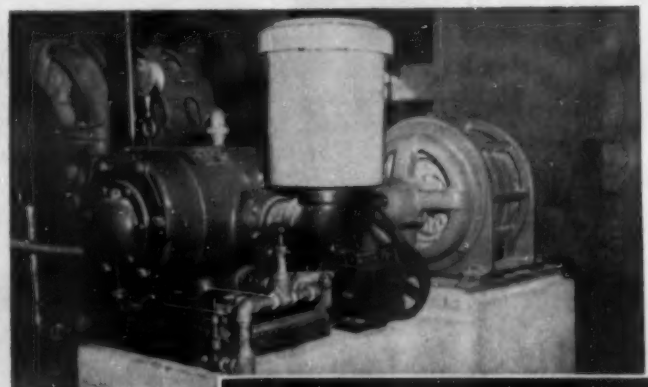
Because it operates at normal speeds, it is direct-connected and requires no cumbersome reduction gearing or belts.

Because of these things, you can put a Fuller Rotary in almost any unused corner, or on a balcony, or even suspended from the rafters, if need be.

So, whenever you are cramped for space and air, you can ease your problem by specifying Fuller.

Pressures to 125 psig; capacities to 3300 cfm.

Detailed information on design characteristics and typical applications will be forwarded promptly on request.



FULLER COMPANY, Catasauqua, Pa.

GENERAL AMERICAN TRANSPORTATION CORPORATION SUBSIDIARY

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1316
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Fuller

. . . . pioneers in harnessing AIR

Copes-Vulcan helps to make

MORE POWER FOR CAROLINA

Carolina Power and Light Company serves 365,000 customers in an area of 30,000 square miles . . . with a transmission system that fans down through the heart of North Carolina and dips deep into South Carolina. CP & L is big . . . and getting bigger.

The latest increase in capacity is an addition to CP & L's Louis V. Sutton Steam Electric Generating Plant at Wilmington, North Carolina. This second generator, combined with Unit 1, gives this outdoor station a capability of a billion and a half kwhrs a year.

Steam to drive the turbines is generated in two boilers operating at 1750 psi at 1005 F. Unit 1 is a Combustion Engineering steam generator with a design load capacity of 950,000 pph. Unit 2 is a radiant-reheat Babcock & Wilcox boiler with design load capacity of 900,000 pph, with reheat to 1005 F. Copes-Vulcan control helps keep these steam generators efficient.

A Copes-Vulcan Combustion Control System accurately regulates the fuel and air for proper combustion. Copes Type 3-L Boiler Feed Water Control keeps boiler drum level constant. A Vulcan Automatic-Sequential Soot Blowing System thoroughly cleans the heating surfaces. You will find details of operation on the next few pages.

COPES-VULCAN DIVISION

CONTINENTAL FOUNDRY & MACHINE COMPANY

ERIE, PENNSYLVANIA

COPES VULCAN

BOILER CONTROL and

With Copes-Vulcan Control, miniature recorders and control stations make for a compact, easily read main control panel at Carolina Power and Light Company's Louis V. Sutton Generating Plant. The operator can tell at a glance how every control is functioning. Without leaving the control room, he can accurately regulate combustion and feed water flow. No high-pressure piping is present at the panel.

COMBUSTION CONTROL

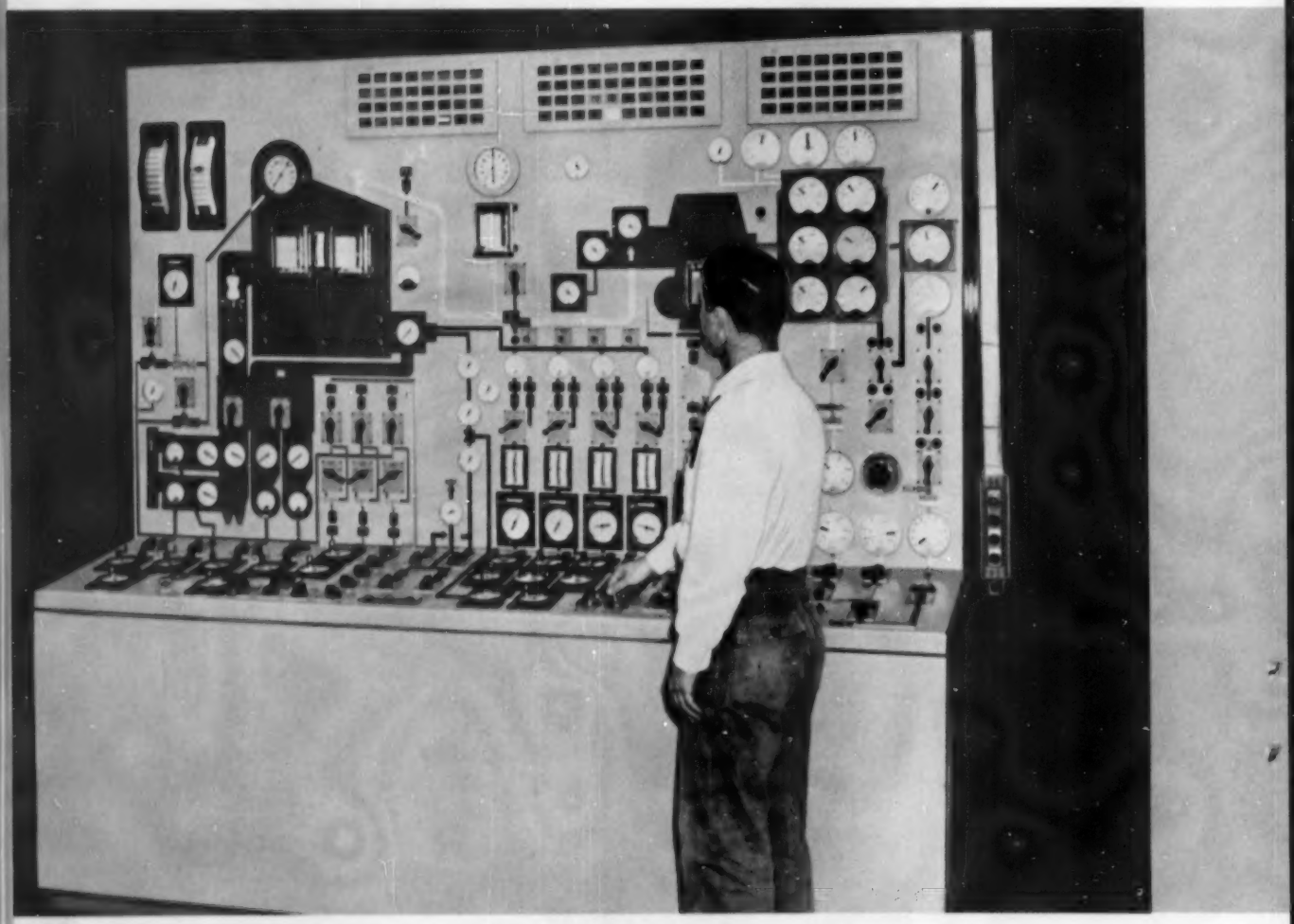
In this Copes-Vulcan System, the ratio of steam flow to air flow regulates the amount of combustion air entering the furnace. The ratio is adjustable to any desired value. Copes-Vulcan drive units assure accurate positioning and fast response. All control forms are carefully placed for circuit simplicity and ease of maintenance.

FEED WATER CONTROL

Copes Type 3-L Feed Water Control accurately supplies feed water to the boiler in accordance with steam demand. It maintains the drum level virtually constant at all loads. Copes provided 10-inch, 1500-pound standard motor-operated feed water by-pass control valves.

PUMP RECIRCULATION

Copes-Vulcan control and valves give automatic recirculation for protection of three Byron-Jackson boiler feed pumps. Normal operation requires two pumps to carry full load . . . and one for stand-by.



BOILER CLEANING

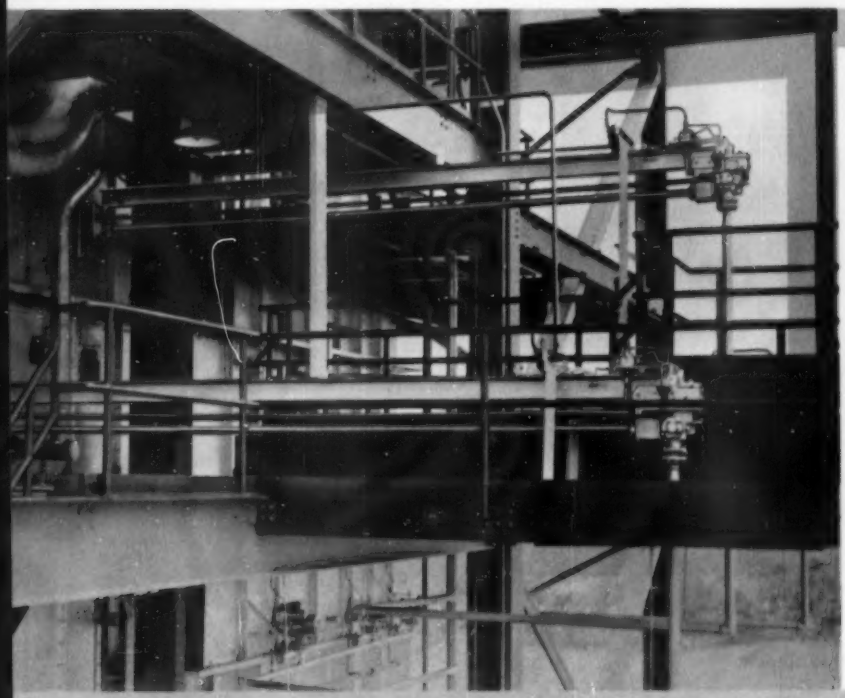
by Copes-Vulcan

Carolina Power and Light Company chose the easiest and surest way to clean boiler surfaces at the Louis V. Sutton Plant —with Vulcan Automatic-Sequential Soot Blowing Systems.

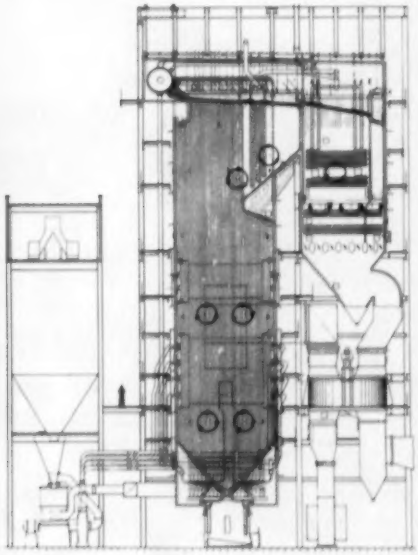
The operator in the boiler control room simply presses a button. The blowing elements go through their paces automatically—and in proper sequence. The operator can change the sequence if necessary, or interrupt the operation, anytime, to control the blowers individually. The control center is complete with indicating features and alarms with interlocks to assure proper and safe operation.

Cleaning elements include Vulcan long retractables, wall deslaggers, rotaries and air preheater cleaner controls. Vulcan equipment is paying off for CP & L in low operating cost and maximum boiler efficiency.

Send the coupon on the next page for complete information about Boiler Control and Boiler Cleaning by Copes-Vulcan.



Dual-motor drives on these Vulcan Long Retractables and the Vulcan Wall Deslaggers give more complete cleaning than would single-motor drives, leaving *no* surface unblown.



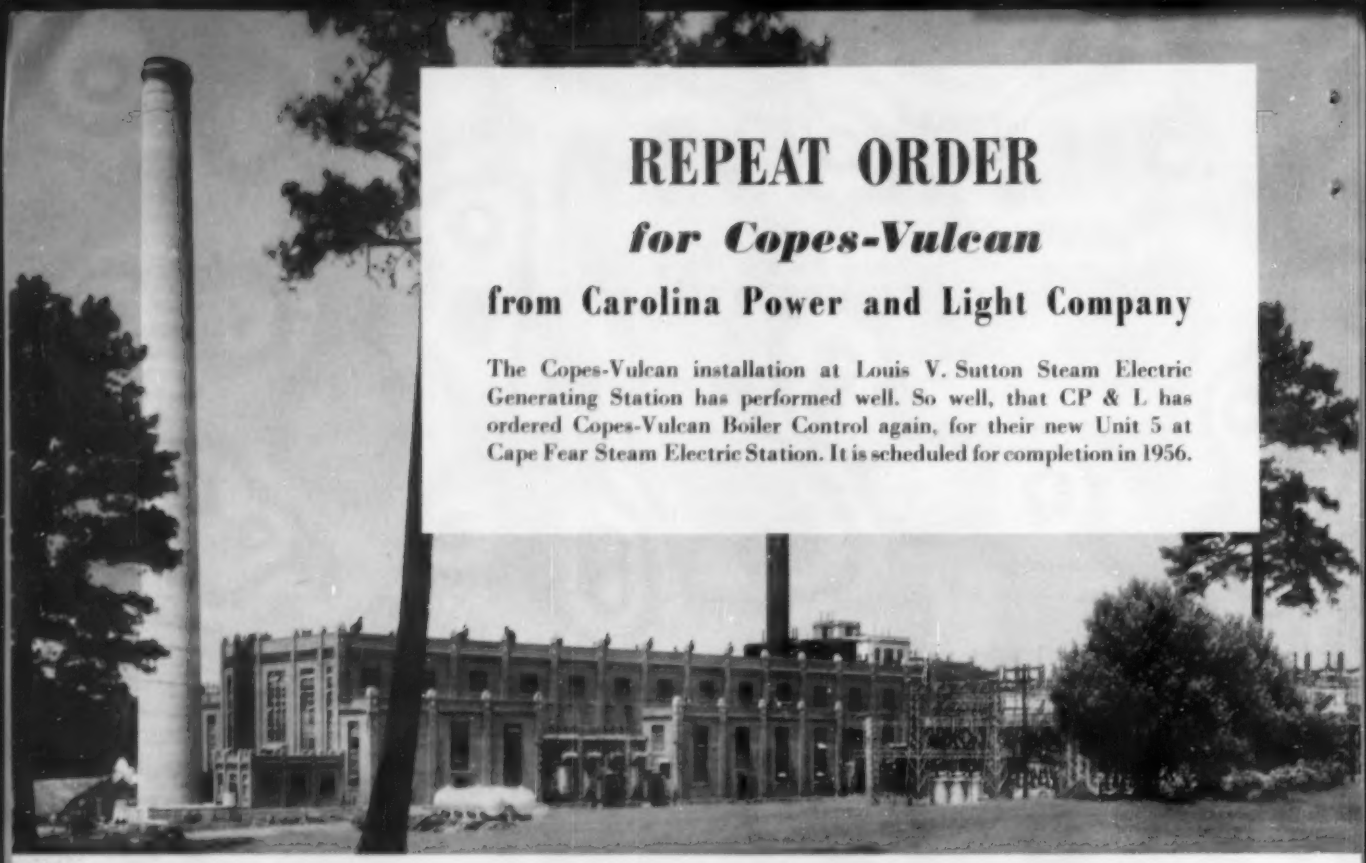
This is the Combustion Engineering steam generator Unit 1.

COPES-VULCAN DIVISION

CONTINENTAL FOUNDRY & MACHINE COMPANY

ERIE 4, PENNSYLVANIA

COPES VULCAN



REPEAT ORDER

for Copes-Vulcan

from Carolina Power and Light Company

The Copes-Vulcan installation at Louis V. Sutton Steam Electric Generating Station has performed well. So well, that CP & L has ordered Copes-Vulcan Boiler Control again, for their new Unit 5 at Cape Fear Steam Electric Station. It is scheduled for completion in 1956.

Why does CP & L select Copes-Vulcan?

Performance. Copes-Vulcan equipment at Louis V. Sutton Station is doing everything asked of it.

Service. Copes-Vulcan maintains perpetual interest in every installation *after* it is in service. Throughout the life of the equipment, trained Copes-Vulcan service men will regularly visit the plant to check performance and see that everything is functioning as it should.

If you'd like this attention on your jobs, give Copes-Vulcan a chance to improve the control and cleaning of your next boiler. Doesn't matter how big it is.

COPES-VULCAN DIVISION

CONTINENTAL FOUNDRY & MACHINE COMPANY

ERIE 4, PENNSYLVANIA

Copes-Vulcan Division, Dept. P-55
CONTINENTAL Foundry & Machine Company
Erie 4, Pennsylvania

Please send information on the following:

- ☐ Copes-Vulcan Boiler Control
- ☐ Copes Desuperheating and Pressure Reducing
- ☐ Copes Boiler Feed Water Control
- ☐ Vulcan Soot Blower Systems

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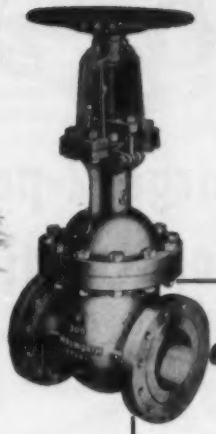
ONLY THE HIGHEST QUALITY OF PRODUCT AND SERVICE TO OUR CUSTOMERS CAN BUILD A REPUTATION WORTHY OF OUR EFFORT.
Copes-Vulcan

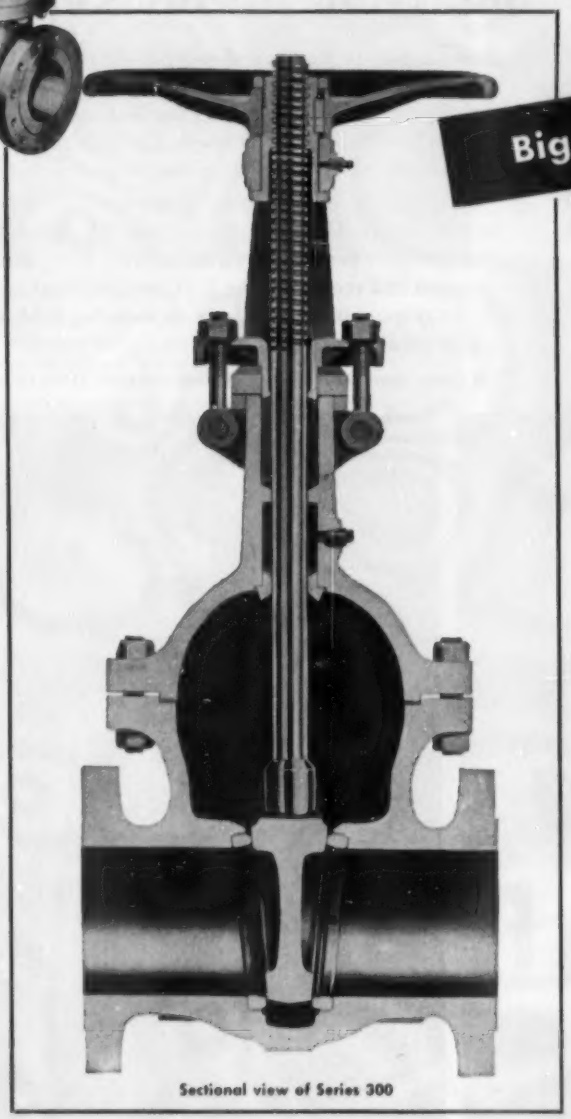
WALWORTH

Cast Steel Gate Valves

Series 150 and 300

Wedge Gate — Outside Screw and Yoke





Sectional view of Series 300

Big 8-Point Superiority!

Gland clearances are such that stem cannot be scored if gland should be tightened unevenly.

Deep Stuffing Boxes in all sizes (2" to 24") insure tightness and maximum packing life — costly leaks are eliminated.

Bonnets and Bodies are engineered to withstand pressure and minimize distortion — they're tough, durable, dependable.

Heavy Steel Walls provide extra strength and longer life.

Integral Body Guide Rib Faces are machined to insure accurate disc seating.

Seat Rings are bottom seated — not flange type. No recess exists at back of ring — hence no turbulence, erosion, or pressure drop.

Streamlined Ports allow high velocity, non-turbulent flow, and reduce the possibility of erosion.

Valves regularly have flanged ends. They can be supplied with ends for butt welding. Roller bearing yokes are available. On valves 5 inches and larger, by-passes can be furnished.

For Series 600 and higher, we recommend Walworth Pressure-Seal Steel Gate Valves.

For further information on Walworth Cast Steel Gate Valves, see your local Walworth distributor, or write:

WALWORTH

valves and fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

The a b c's of NEWEST large 2-pole Induction Motor Construction

Here's a picture sequence showing a big E-M 2-pole boiler feedwater pump motor* in construction. Step by step you can observe the modern engineering and meticulous care given to every detail by E-M craftsmen. The little rhymes will call your attention to the key points in each picture.

As you know, requirements for big motors are exacting . . . the duty severe. Here you can see how E-M builds in extra quality to give you top performance, reliability, smooth operation and economy. The E-M sales engineer in your area has many more interesting facts on these big E-M Motors he'll be glad to tell you.

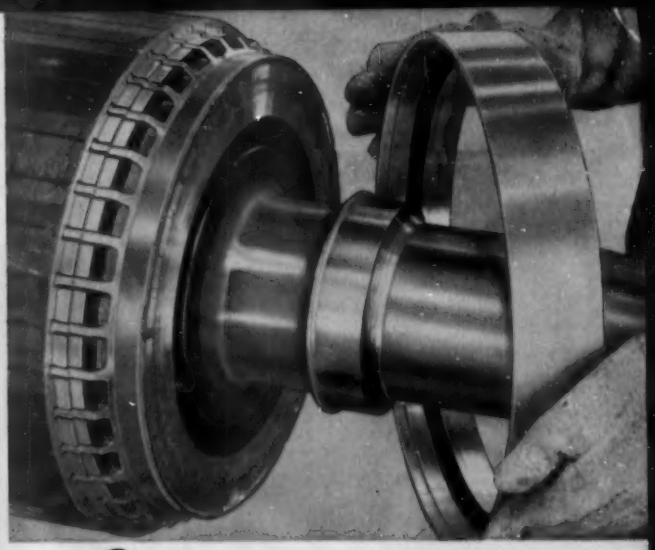
*E-M 2-pole Heavy-Duty Squirrel-Cage Induction Motor (1500 hp and larger)

a A's for All-welded, this reinforced frame;
It's made extra rugged to stay in the game.
All welds are continuous, tested for strength—
There'll be no distortion in width or in length.

b Burrs are removed before laminations are stacked,
For a low-loss core that is true and compact.
The baked-on enamel coating of each lamination
Provides high dielectric strength and corrosion elimination.

c C is for Coils, with vacuum impregnation
To provide the best in protective insulation.
They're form-pressed to slot size to fit on the dot . . .
Each coil is surge-tested before reaching its slot.

d D is for Diligence in anchoring the winding . . ,
Each coil side is lashed to provide an "arch" binding.
These tight E-M coil ends won't be twisting or parting
In any hard demand of full-voltage starting!

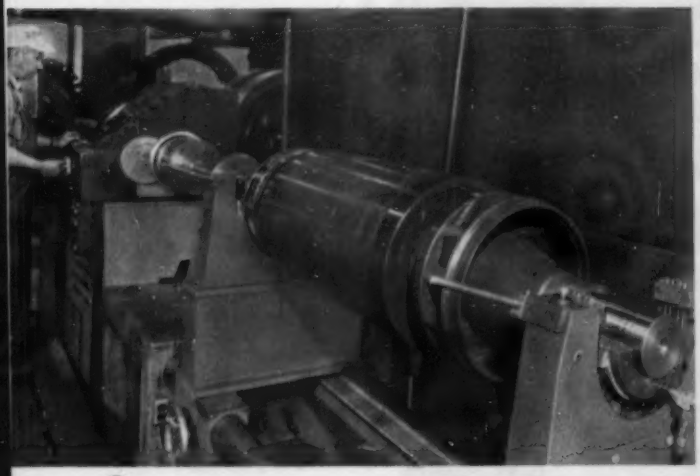


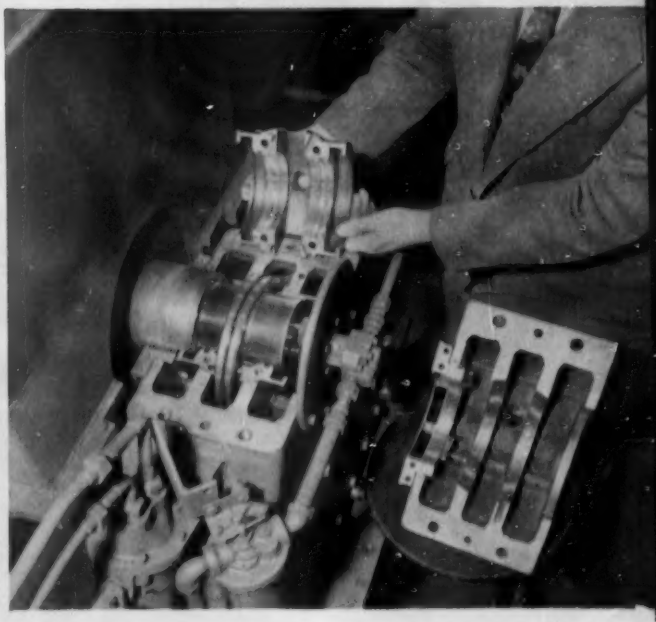
f

F is for Freedom from centrifugal force distortion,
In end-ring structure and retaining ring portion.
The cage bars fit rotor slots snug and tight—
Joints are silver-brazed; they stay just right.

e

Extra protection for the E-M wound stator . . .
It's full-flooded with varnish—a real first-rater!
It's baked and re-flooded and re-baked at a pace
That seals the coil surface in every place.



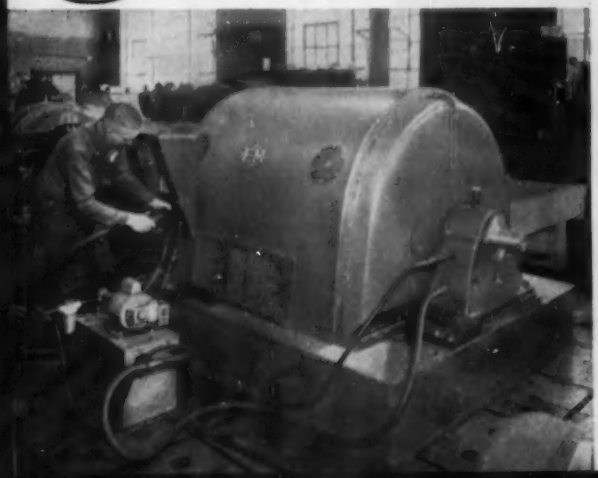


g

G is for the Gisholt electronic machine
That checks rotor balance with an eye true and keen.
Again in the stator we check balance of the rotor
Because it's so important to a smooth-running motor.

h

High finish on journals, superfinish is the rule.
The bearings are well-sealed . . . they'll run long and cool.
The sleeves are Kolene-processed to last and last.
Double oil rings start lubrication safe and fast.



i

Inspection is thorough, when we've done all the rest,
For each E-M machine stands a rigorous test.
When it's installed in your plant, you know it can take it . . .
It's bound to be rugged, for it had experts to make it!

Like to know more about this 2-pole Motor beauty
For feedwater pumps or other hard-driving duty?
Just call your nearest E-M sales engineer now
For facts, data and application know-how.
Or write to the factory—there's much you can glean
From E-M's new brochure Number 214.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

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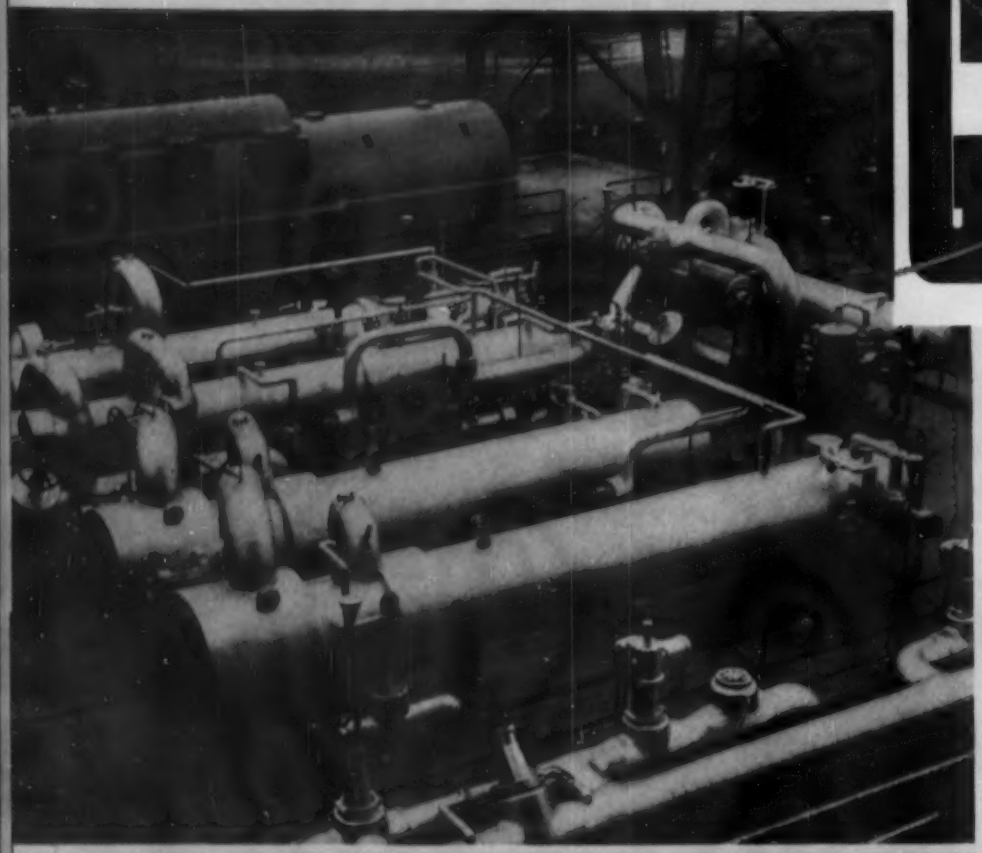
E-M

Specialists in making motors do exactly what you want them to

One of a series telling
how the producing companies of
General Precision Equipment Corporation
are contributing to America's progress.

GPE.....



Griscom-Russell feed water heaters in a 125,000 KW public-utility power station, save nearly 100 tons of coal per day. Heaters handle flow of water exceeding 2000 G.P.M. at 2500 pounds pressure and steam extracted from the turbine at five different points; "train" of five units preheats water fed to boilers from 90° F. to 441° F.

Askania multiple fuel boiler control panel in large steel plant; maintains metered proportion between combustion air and fuels—coke oven gas and fuel oil—for most economical combustion; holds steam pressure constant through all load changes and keeps furnace pressure at a safe and predetermined value.

General Precision Laboratory's Industrial TV Camera, the "Bullet"; portable, easily operated; used to monitor and improve manufacturing processes and to view hazardous industrial operations.

The highly advanced technological products designed and manufactured by the eighteen producing companies of General Precision Equipment Corporation serve more than a dozen major industries. Products of six of these GPE Companies—Griscom-Russell, Askania, Librascope, Link, Kearfott and General Precision Laboratory—have widespread application in the processing and power industries.

Industrial Processing...and Power

The Griscom-Russell Company is one of the country's largest producers in the fields of heat exchange and water distillation. It is the pioneer in heat exchanger equipment—the key to the whole complex of modern industrial processing and power. For over seventy years, G-R equipment has been responsible for greatly increased efficiency and lowered operating costs in industry.

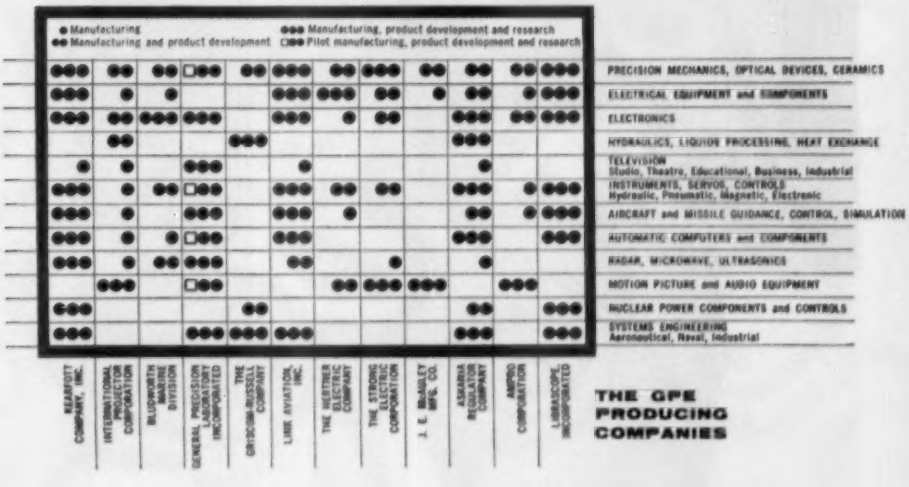
Askania Regulator Company for a quarter of a century has been a leading developer in the field of regulators and controls, including components and systems. Its products are widely used by the power, steel, gas and coke, mining, chemical, petroleum, glass and paper industries—wherever great reliability and accuracy are essential.

Kearfott Company, Inc.; Librascope, Incorporated; and Link Aviation, Inc. produce a wide variety of precision instruments, computers, servos and other control components for equipment and systems used throughout the power and the processing industries. Industrial television equipment manufactured by General Precision Laboratory Incorporated, the sixth GPE Company active in these fields, is playing increasingly important roles in "seeing eye" monitoring operations in these industries.

Each company in the GPE Group works in specific, highly specialized technical areas, as indicated in the chart below. Each of these companies, in addition to specializing in its particular products and fields of technical competence, has at its command, as required, the facilities and specialized techniques of the other GPE Companies in their respective fields. Interrelation is achieved through GPE's basic operating policy, Coordinated Precision Technology.

In the fields of research and development, GPE Coordinated Precision Technology permits a high degree of specialization in particular areas of competence and supplements such specialization by the application of techniques in other fields, as desirable. In the field of production, it makes possible a highly flexible application of facilities. This policy has been responsible for a diversified line of precision equipment of superior design and performance, covering a wide range of both standard and special uses.

Perhaps the most conspicuous advantage of GPE Coordinated Precision Technology is that the concept and development of equipment, and of solutions to the underlying technical problems, are not restricted or distorted by traditional allegiance to specialization in a particular field. GPE coordination permits the engineers and technical personnel of each GPE Company to seek the optimum solution for the customer within the total capacities of the GPE Companies as a group.



THE GPE PRODUCING COMPANIES

A brochure relative to GPE Coordinated Precision Technology and the work of the GPE Companies is available. Address your request, or inquiries on specific problems, to:

General Precision Equipment Corporation

92 GOLD STREET, NEW YORK 38, NEW YORK

MOTOR CONTROL FACTS
ON INDUSTRY'S
MOST COMPLETE LINE

FACT: Here is industry's newest and most advanced high-voltage starter!

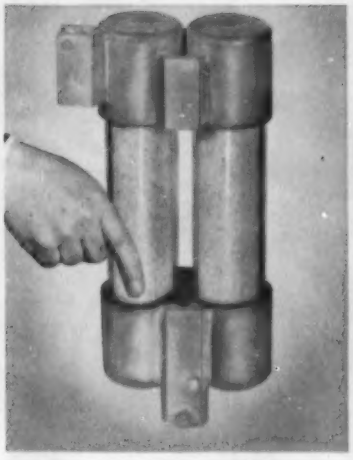
This new line of Westinghouse high-voltage fused starters offers industry more protection—more operating simplicity than any other. Here are a few reasons why:

Extension of the BAL fuse line up to 400 amperes with the first and only 400-ampere, double-barreled, single-unit fuse; a new 50,000-kva air break contactor featuring the most advanced arc interrupting action yet developed; and new enclosures providing new levels of convenience and safety.

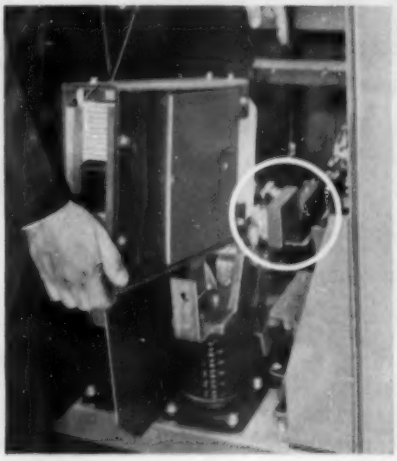
Booklet B-6535 has more facts on this outstanding new starter. Get it from your Westinghouse engineer —or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa.

J-21898

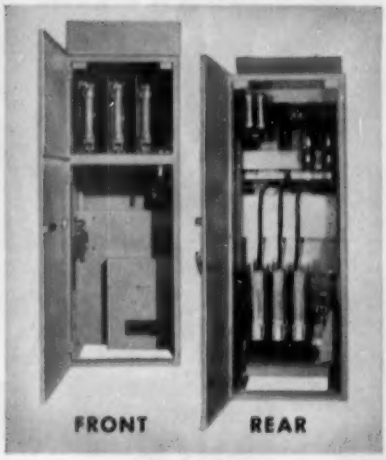
YOU CAN BE SURE... IF IT'S Westinghouse



New 400-ampere, double-barreled, type BAL fuse features "no-bolt" brazed connections which insure equal division of current. Complete coordination of fuses is assured. Exclusive BAL single-barreled design for fuses up to 200 amperes is retained.



New air break contactor (200 and 400-ampere sizes) features a unique arc chute design which greatly simplifies inspection and maintenance of the contacts. Simply pull the arc chute down —contacts are immediately and conveniently accessible.



New enclosure design provides both mechanical and electrical interlocks; front and rear access DOORS; top-mounted bus arrangements; separate compartmentation of high and low-voltage components—all designed for maximum safety of personnel.

FROM INDUSTRY'S MOST COMPLETE LINE OF INDUSTRIAL CONTROL

CONTROL COMPONENTS • MOTOR CONTROL • ELECTRONIC CONTROL • CONTROL SYSTEMS • NATIONAL SERVICES

Allis-Chalmers Supplementary Treatment

Eliminates All Scale!

WATER SOFTENING PLANTS SELDOM REMOVE all scale-forming material. In fact, only one part per million of hardness in feedwater will amount to twenty pounds of scale or sludge after twenty million pounds of steam is generated. In even a short period, this build-up can cause serious trouble. In addition, condensate is frequently contaminated.

To solve this problem, Allis-Chalmers has developed its supplementary treatments, which are formulated specifically to the requirements of individual plants.

You can find out about factors involved in designing the proper supplementary treatment in Allis-Chalmers Water Conditioning Informational Bulletin 52. It explains how Allis-Chalmers water conditioning engineers approach this problem. Get a copy from your nearby A-C office or write Allis-Chalmers, Milwaukee 1, Wis.

A-4594

ALLIS-CHALMERS

WATER CONDITIONING—CHEMICALS, EQUIPMENT,
SERVICE—FOR OVER 25 YEARS

A-C ALLIS-CHALMERS

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PLATE FABRICATION FOR POWER PLANTS

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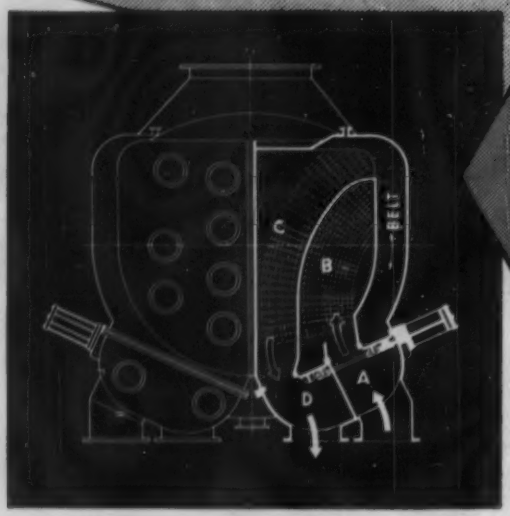
FABRICATION

Whatever your requirements in fabricated plate, sheet or structurals for power plant use . . . call on experts!

Kirk & Blum has fabricated a variety of power plant needs as big as the mammoth breeching section shown here. In a 150,000 sq. ft. plant, with crane capacity to 25 tons, Kirk & Blum has complete facilities to produce, pre-assemble and load the largest fabrication. Kirk & Blum has the men, materials and experience to do the job quickly and economically.

For detailed literature, write: The Kirk & Blum Mfg. Co.
3233 Forrer St., Cincinnati 9, Ohio

C. H. WHEELER "SELF CLEANING"
PATENTED
REVERSE FLOW STEAM CONDENSER



REVERSE FLOW

Illustrated is the C. H. Wheeler tandem arrangement in which both sluice gates operate on a single stem. In this divided water box condenser, water enters chamber A with left hand port open and flows in through pass B, out through pass C and through left hand port D. To reverse the flow, gates move to left, closing the left hand ports and opening the right hand ports of chambers A & D. Water now flows through belt, in through C and out through B and right hand port of D. The same method applies, of course, to a non-divided water box design.

No Shutdown — No Vacuum Loss for Tube Cleaning

The C. H. Wheeler Patented Reverse Flow design makes either single or divided water box steam condensers self-cleaning. These condensers are saving power plants countless hours of downtime and reduced load formerly required for manual removal of debris and organic growth from clogged tube sheets.

"Self-Cleaning" is accomplished by a set of sluice gates built integrally into C. H. Wheeler Surface Condensers which may be electrically or hydraulically operated to reverse the flow of cooling water through the tubes. This sudden flushing-in-reverse removes all debris and crustaceous matter and carries it out the discharge while carrying full load on the turbine and without reducing water flow. Also, the quick change in temperature shocks and dislodges marine growth.

Depending on condition of the cooling water, C. H. Wheeler Reverse Flow condensers have gone two years and longer before requiring cleaning. A typical field report tells of regaining a half-inch loss of vacuum (due to fouled tubes and tube sheets) five minutes after reversing the flow of condenser cooling water.

C. H. Wheeler custom - designs Reverse - Flow Condensers to suit any installation, arranging sluice gates and nozzles at top or bottom of water box and at any angle desired. Call a C. H. Wheeler representative to go over your specifications. It will mean years of substantial savings.

(BULLETIN 410 mailed on request)

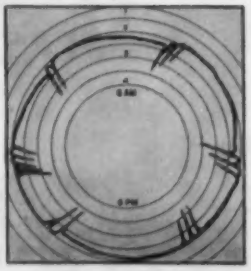
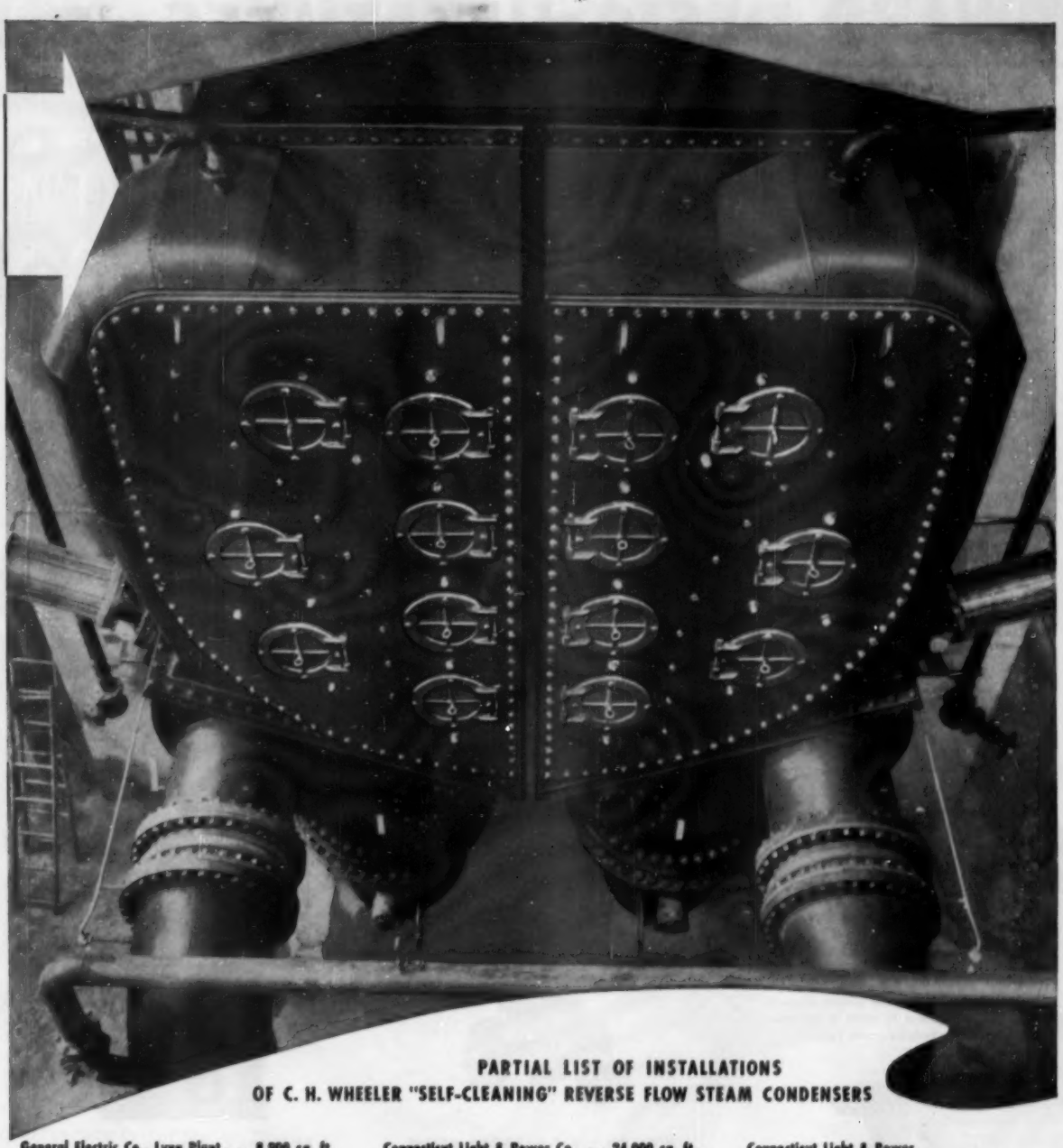


Chart shows typical cycle of vacuum and effect of reverse flow in a C. H. Wheeler Patented Self-Cleaning Reverse Flow Condenser. Note that because of 100% back flushing, the loss of vacuum during the reverse flow cycle is negligible.



PARTIAL LIST OF INSTALLATIONS
OF C. H. WHEELER "SELF-CLEANING" REVERSE FLOW STEAM CONDENSERS

General Electric Co., Lynn Plant . . 8,900 sq. ft.
General Electric Co., Lynn Plant . . 12,500 sq. ft.
Keystone Steel & Wire, Peoria . . 10,000 sq. ft.
Virginian Railways, W. Va. . . . . 15,000 sq. ft.
City of Wyandotte, Mich. . . . . 12,000 sq. ft.
City of Kansas City, Kansas. . . . 32,500 sq. ft.
New Bedford Gas & Edison Light,
New Bedford, Mass. . . . 16,500 sq. ft.
New Bedford Gas & Edison Light . 25,000 sq. ft.
Connecticut Light & Power Co.,
Montville Station . . . . . 24,000 sq. ft.
Connecticut Light & Power Co. . . 24,000 sq. ft.
Connecticut Light & Power Co.
Devon Station . . . . . 50,000 sq. ft.
Georgia Power Co., Atkinson Station, 47,000 sq. ft.
Alabama Power Co , Units 1 & 2
Gadsden Station . . . . . 47,000 sq. ft.
City of Holland, Michigan . . . . . 13,000 sq. ft.
South Carolina Electric & Gas,
Unit #1 Urquhart Station . 45,000 sq. ft.
South Carolina Electric & Gas,
Unit #2 Urquhart Station . 45,000 sq. ft.
Connecticut Light & Power,
Montville Station . . . . . 55,000 sq. ft.
Monongahela Power Company,
Albright #3 . . . . . 65,000 sq. ft.
Georgia Power Company,
Hammond Station, Units 1-2-3, 74,000 sq. ft.
City of Jacksonville, Fla.,
Southside Station . . . . . 40,000 sq. ft.
Tallyrand Station . . . . . 40,000 sq. ft.

C. H. WHEELER *of Philadelphia*

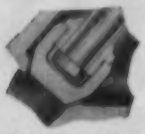
C. H. WHEELER MANUFACTURING CO., 19th & LEHIGH, PHILADELPHIA 32, PENNA.

Steam Condensers • Centrifugal, Axial and Mixed Flow Pumps • Steam Jet Ejectors • Vacuum Refrigeration
High Vacuum Process Equipment • Micro Particle Reduction Mills • Marine Condensers and Ejectors • Deck Machinery

EDWARD DESIGN FEATURES assure

ALL ARE "FIRSTS"... MANY ARE "EXCLUSIVES" ...EACH MEANS A BETTER VALVE

INCLINED STEM VALVES First to build inclined stem forged globe stop valves and check valves. Edward construction eliminates turbulence, cuts wear, reduces pressure drop 25 to 50 per cent.

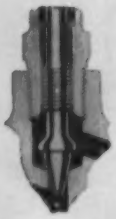


RADIUS STEM HEADS Radius of stem head assures application of closing load at center of disk. Curvature of inside of disk, in contact with stem head, centers disk for sure, tight seating.

FOOLPROOF STEM BACKSEATS Spherical stem or disk nut surface contacts taper bonnet surface to make a pressure-tight backseat. Exclusive with Edward.

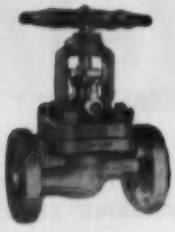
UNIVALVE* BONNET JOINT Patented leak-proof welded body-bonnet joint assures perfect alignment of working parts, permits disassembly if ever necessary.

EVALIZING* Exclusive Edward process electro-plates parts with wear-resistant metallic lubricous material. Reduces wear and friction between internal valve parts 50 per cent or more. Ideal for temperature service.



TAPER THREAD BONNET JOINT Taper threaded joint in small forged gage valves gives tight seal, withstands extreme pressures.

CROSS ARM IMPACTOR* HAND-WHEEL Now the famous Edward Impactor principle is applied to small valves. Easy-to-grip cross-bar delivers 2.8 times the closing load of ordinary handwheels. No wrenches or extensions needed.



FORGED STEEL FLANGED VALVE DESIGN Edward designed first forged valves with symmetrical, uniform wall thickness. Eliminates thermal distortion and stress, cuts needless weight.

SWING BOLT RETAINER New type retainers keep packing gland swing bolts in place on integral forged support pins, yet out of way for easy repacking.

NO-BONNET INSTRUMENT VALVE No chance for bonnet joint leak with these compact all forged valves for toughest instrument line service.

WELDED-ON FLANGES Edward patented first valve constructions using welded flanges. Permits super strong drop forged bodies.

EVALPAK* PACKING Edward developed first asbestos-graphite packing with special processing to prevent stem pitting. Die molded, wire supported, low operating torque.

OTHER EDWARD FIRSTS! **Patented EValthrust* yoke bushings . . . Impactor* handwheels . . . Closure indicators . . . Streamlined cast steel body contours . . . Three-point disk guiding . . . Self-centering disk throttling lip . . . Free floating tubular disk-piston . . . Edward Equalizer* . . . Edward Pressure-Seal design . . . Integral seats . . . Seat-located guide ribs in gate valves . . . Hour-glass type disk-piston . . . Separated feedline stop-check valves . . . Part interchangeability in stop, check and non-return valves.**

*Registered trade name of Edward Valves, Inc.

ROCKWELL-BUILT EDWARD VALVES

YOU top FORGED STEEL VALVE VALUE

DON'T SETTLE FOR LESS OR PAY MORE

Forged Steel valves, because they are small, sometimes don't get the attention they deserve when specifications are drawn.

But the smallest valves, if not equal to the service to which subjected, may be the most troublesome. Therefore, it pays to take time to analyze design features and to study actual service records.

If you do, you'll find that Edward forged steel valves are the most copied in the field. You'll find that dozens of features that were Edward "firsts" are now accepted as industry standards. But you'll also find that there are still many patented features exclusive with Edward.

Edward pioneered *forged steel* valve construction, and Edward design developments have consistently been a step ahead of mounting service requirements, piling up outstanding service records in some of America's most famous power plants and process installations.

For steel valves for pressures from 150 to 7500 lb, expect the best *first* from Edward.

Always specify Edward. Only Edward Valves Equal Edward Quality and Performance.

New design Fig. 444-448 and 944-948 series *all forged steel* globe and angle valves, 600 and 1500 lb sp, bolted or union bonnet, screwed or welding ends. Fig. 444 illustrated.

***All forged steel* welded bonnet Univalves®, 1500 and 2500 lb sp. integral Stellited seat, Stellited disk, chrome-moly body, with permanent or removable backseat for disassembly in the line. Fig. 2224 illustrated.**

Another Product

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

1230 West 145th Street, EAST CHICAGO, INDIANA

TURBINES FOR
HIGH-SPEED COMPRESSORS

VIBRATION RECORD, inset, is obtained by exciting buckets. Peaks indicate resonant vibration response of buckets. For more reliable operation, G-E engineers confine bucket exciting frequencies to "quiet zones" between the peaks.

How G-E Engineers Locate "Quiet Zones" for Safer High-speed Turbine Operation

TYPE DRV HIGH-SPEED MECHANICAL-DRIVE TURBINE

When driving modern compressors and blowers, G-E high-speed turbines spin at operating speeds of 7000 rpm and up. At such speeds, if resonant vibration were not controlled carefully, bucket fatigue failure might result.

HERE'S HOW General Electric combats the problem: Natural vibration frequencies of the buckets on each new turbine rotor are determined with the special equipment shown above—an oscillator, crystal pick-up, and high-speed level recorder. "Quiet zones" of minimum normal vibration are clearly revealed.

With this information available, the number of nozzles can be varied so that steam striking the buckets will create vibration-exciting frequencies only in these "quiet zones." By thus making sure that steam-impact frequencies don't coincide with critical natural frequencies, the chance of bucket failure is greatly reduced.

VIBRATION TESTING is one of many features that add to the reliability of G-E high-speed turbines. For more information, contact your nearest G-E Apparatus Sales Office or write General Electric Company, Schenectady 5, N. Y. 241-2

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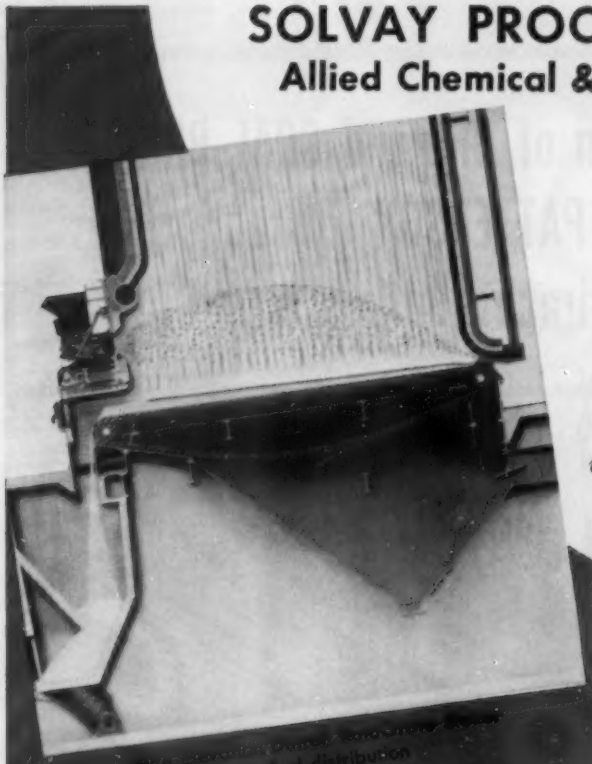
SOLVAY PROCESS DIVISION
Allied Chemical & Dye Corporation

USES DETROIT ROTOGRATE STOKERS

at Moundsville to Burn West Virginia Coal

Detroit RotoGrate is a modern spreader stoker with grates that move slowly forward, discharging ash at the front. It will burn any type of Bituminous coal or Lignite and many types of combustible refuse with high efficiency. Handles rapidly fluctuating loads. Produces more capacity per square foot of grate area. Precise control of fuel feed with grate speed and air supply provides smokeless operation.

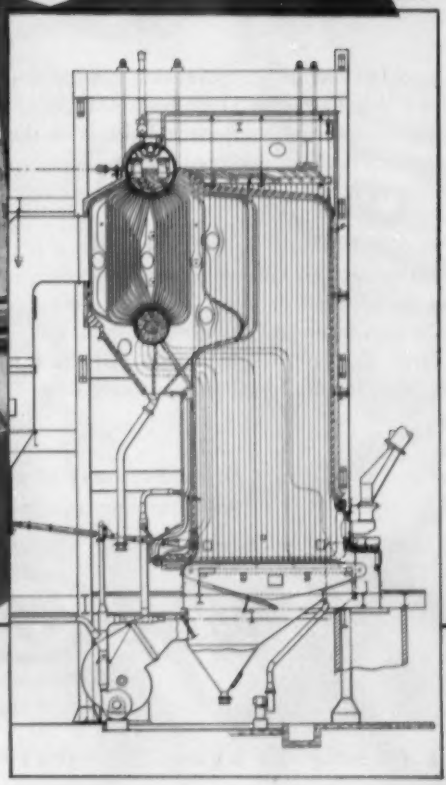
There is a size and type of Detroit Stoker for every industrial need.



Rear elevation, Detroit RotoGrate Stoker shows uniform fuel distribution and continuous cleaning feature.

Moundsville, West Virginia, (Marshall County) Plant, Solvay Process Division, Allied Chemical & Dye Corporation.

Detroit RotoGrate Stoker with Babcock and Wilcox two drum Stirling boilers in Moundsville Plant



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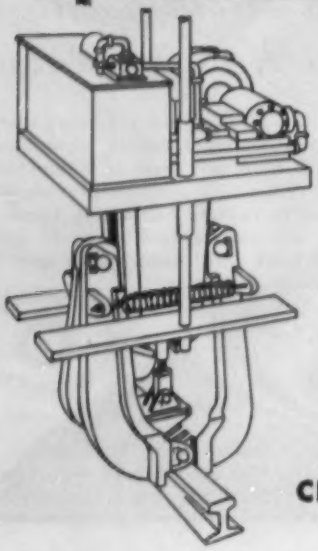
GENERAL MOTORS BLDG. — DETROIT 2, MICH.
DISTRICT OFFICES IN PRINCIPAL CITIES • WORKS AT MONROE, MICH.

the utmost **SAFETY**

in the Operation of ORE and COAL BRIDGES Makes HEYL & PATTERSON Hydraulic Rail Clamps and Hydraulic Buffers a MUST!



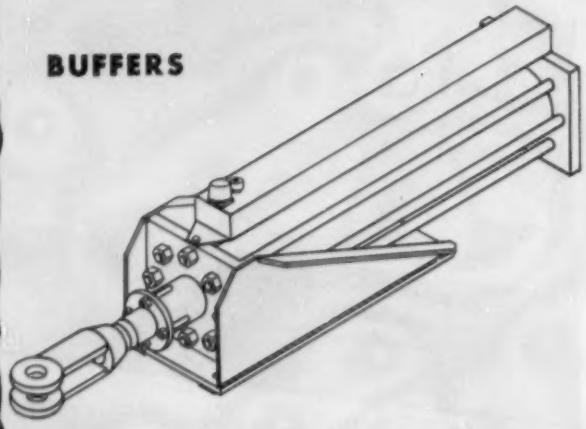
RAIL CLAMPS

If a coal or ore bridge moves due to wind or over-skews due to electrical or human failure, then safety of men and equipment depends on the rail clamps. They are designed to set automatically in case of interruption of power due to over-skew or high wind.

H & P hydraulic rail clamps afford a positive holding force on runway rails. Clamp setting time can be adjusted between 2 and 10 seconds, and units in sizes up to 75 tons each can be furnished.

Heyl & Patterson hydraulic rail clamps are available in suitable sizes to protect new or old structures.

BUFFERS



If the trolley is headed for the end of the runway, and control is lost because of electrical or mechanical failure, ice on rails, or operator incapacity, safety of men and equipment depends on the buffer. H & P hydraulic buffers afford positive controlled deceleration when all else fails.

Because this buffer is pull-type, the piston is fully protected when not in use, and a minimum of maintenance is required. A latching device on the trolley resets the H & P buffer assembly automatically.

Heyl & Patterson hydraulic buffers are available in 2, 4, and 6 foot travel for both old and new installations.

Heyl & Patterson's 50 years of experience with movable structures can help you increase the safety of your equipment.

Heyl & Patterson INC.

55 FORT PITT BLVD. PITTSBURGH 22, PA. PHONE COurt 1-0750

Proof of PERFECT* Water Treatment PERFORMANCE

Nearly 12 billion pounds of steam have been generated inside this boiler and its twin. Boilers have never been acid cleaned. Tubes have never been turbined. All water side surfaces are clean-to-metal.

TURN THE PAGE FOR MORE FACTS ON HOW IT WAS DONE

*We at think at least 99%!

BOILER OPERATING DATA

● Two new boilers were put on line in a Southwestern municipal utility plant at the same time late in 1949. Rated capacity of each unit is 250,000 pounds of steam per hour at 950 p.s.i. Normal operating rates range from 150,000 to 175,000 pounds of steam per hour per unit.

The Nalco System of water treatment has been used continuously in these boilers. Raw water softening is by Nalcite* Ion Exchange Resins, and other Nalco products are used for after-treatment, internal treatment, and condensate return line protection. Results have been perfect. Boilers have never been turbined or acid cleaned, and are opened only for annual internal inspection.

Registered Trademark

CLEAN . . . FOR TOP HEAT TRANSFER EFFICIENCY
What appear to be chalk marks in this unretouched photo are scrape marks which indicate only the usual powdery film left on the metal when the boiler is drained.

AND THE MUD DRUM IS SPOTLESS, TOO!
Another unretouched photo inside the mud drum of one of the boilers shows the like-new condition after years of service. No deposits or corrosion of any kind have been found in tubes or drums.

Nalco ON THE JOB

● Results like these are encountered every day in plants when the complete Nalco System of water treatment is on the job. The Nalco System is adaptable to old and new plants of any capacity, temperature, or pressure. Whether you operate a public utility or a space heating boiler, you will find your Nalco Representative of real assistance in the solution of your water treatment problems. Call him today, or write for full information.

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In Canada: Alchem Limited, Burlington, Ontario

THE *Nalco*® SYSTEM . . . Serving Industry through Practical Applied Science

EAGLE-PICHER

ONE-COTE CEMENT

INSULATES, PROTECTS, FINISHES, in one quick application!

ONE QUICK APPLICATION saves time, work and money. Eagle-Picher One-Cote Insulating Cement is clean, easy to handle—provides a smooth, light-reflectant surface. Just trowel it on *hot or cold* equipment—even *irregular* areas where application of other insulations is often impractical.

ONE QUICK APPLICATION assures a highly efficient insulating job that is effective at temperatures up to 1000F. In outdoor installations, quick-setting One-Cote Cement withstands rain and moisture two hours after application. When used indoors, you need no wire mesh or finishing treatment.

ONE QUICK APPLICATION gives you a fast-setting, rust-inhibitive combination that insulates, protects and finishes. One-Cote Cement spreads easily, gives exceptional coverage and is amazingly efficient.

WRITE FOR FREE SAMPLE TODAY!

Prove to yourself, on your own equipment, how Eagle-Picher One-Cote Cement can save you time, money and valuable man-hours!

Since 1843

EAGLE EP PICHER

THE EAGLE-PICHER COMPANY

Producing a complete line of industrial insulations

Cincinnati 1, Ohio

(Member of Industrial Mineral Fiber Institute)

(Conforms to Commercial Standard CS117)

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why Springfield receives so many Repeat Orders!

JOHN DEERE—
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CATERPILLAR—
9 Springfield Boilers
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Re-orders Springfield
1 unit—1932
1 unit—1950
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U.S. GOVERNMENT AGENCIES
30 Springfield Units since 1950

*SPRINGFIELD Provides

- Sound Engineering Design
- Superior Craftsmanship
- Reasonable First Cost
- Ease of Operation
- Low Operating Cost
- Guaranteed Performance
- Minimum Down Time
- High Efficiency

For Information and Prices on Springfield's Package Generators write

KEWANEE-ROSS CORPORATION
KEWANEE, ILLINOIS

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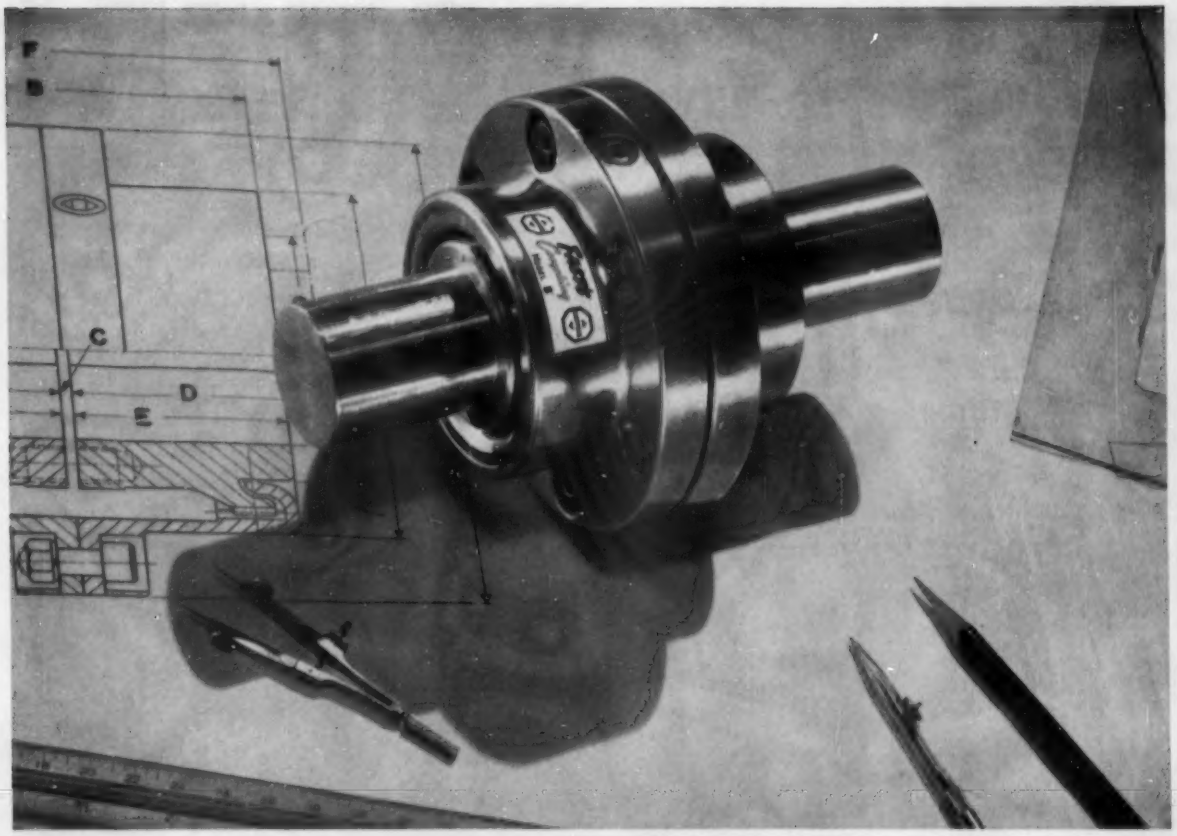
Worldwide Sales and Service

SPRINGFIELD BOILER CO.

FOUNDED IN 1890
DIVISION OF *John W. Hobbs Corporation*
1953 E. Capitol Avenue Springfield, Illinois



Now for the first time, a Fast's Coupling for light and medium drives—at a new low cost!

It's the new Fast's Coupling MODEL B—a lighter, smaller coupling with all the famous Fast's features never before available at such a low cost!

The new MODEL B fills the needs of manufacturers of fans, blowers, pumps and other light-to-medium drive units where coupling *cost* is as important as performance. Koppers engineers designed it to eliminate the cost barrier and offer Fast's rugged design and trouble-free performance for hundreds of new applications.

All steel, dust and moisture proof with metal-to-metal seal, Fast's MODEL B is available for shaft sizes up to 2⅝". Like all Fast's Couplings, it's *sold with service* . . . Koppers *free* engineering service that guarantees the right coupling for the job.

The new Fast's MODEL B Coupling may offer a profitable solution to your light or medium drive coupling problems. Find out how by writing for full details to: KOPPERS COMPANY, INC., Fast's Coupling Dept., 226 Scott St., Baltimore 3, Md.

THE ORIGINAL **FAST'S Couplings**

KOPPERS

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE, MD. This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Koppers Electrostatic Precipitators, Aeromaster Fans and Gas Apparatus. *Engineered* Products Sold with Service

KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* **226 Scott St., Baltimore 3, Md.**
Gentlemen: Please send me more detailed information on the new Fast's Coupling MODEL B.

Name.....

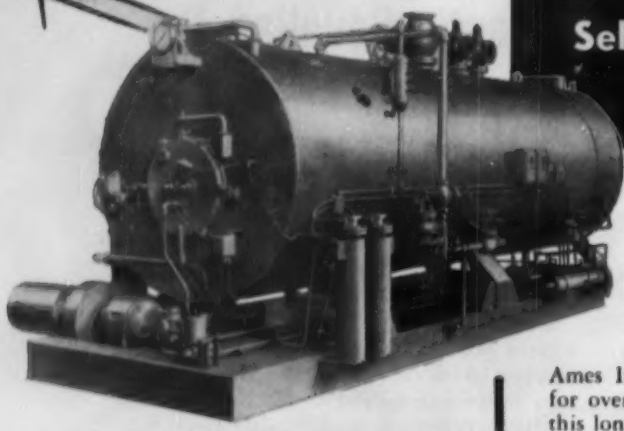
Company.....

Address.....

City.....Zone.....State.....

SO YOU HAVE TO BUY A BOILER!

Select an AMESTEAM GENERATOR and solve all your problems



You don't have to dig through mountains of data to pick the boiler that will give your company the most economical and satisfactory service! It's more a question of *where* you buy it than what boiler you choose. What's the maker's reputation?

Ames Iron Works have been building boilers of quality for over 100 years. Back of every Amesteam Generator is this long, successful experience — represented by the Ames Engineering Staff, a large group of skilled boiler makers and an efficient, nation-wide sales and service organization at your disposal. Yes, quality and experience *do* count — and the thousands of Amesteam Generators giving dependable, low-cost service in power, process and heating applications are proof of it. Why not be *sure* by specifying Amesteam Generator? Write today for details and name of your Ames representative.

AMESTEAM GENERATOR

- 80% guaranteed thermal efficiency.
- Single economical package purchase.
- Package installation economy.
- Completely safeguarded.
- Easy, inexpensive maintenance.
- 20 sizes, 10 to 600 H.P., 15 to 200# W.P., oil, gas or oil-gas combinations with quick fuel switchover feature.

AMES IRON WORKS, INC.
BOX H-65, OSWEGO, N. Y.

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ROTARY SHAFT SEAL

SOLVES **many of today's packing problems**

ELIMINATES **costly fluid losses**

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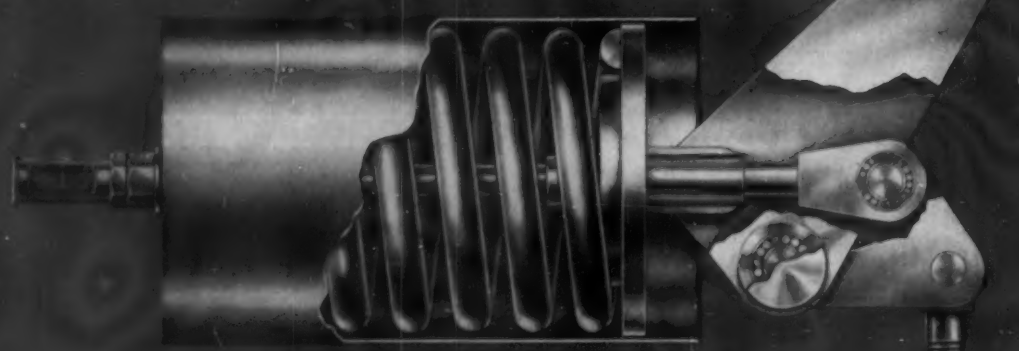
FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

You Get Time-Tested Dependability With



NAVCO Counterpoise*

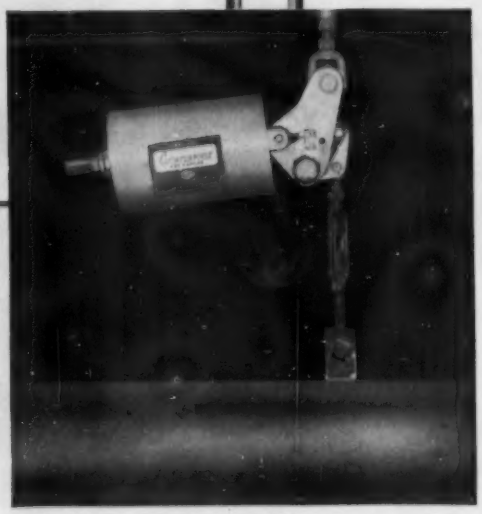
Pipe Hangers

The constant load-carrying capacity of Navco Counterpoise* Pipe Hangers has been proven during an extended period of satisfactory service as the first accurate and efficient support for high temperature piping systems. They are being used extensively in steam generating stations, refineries and chemical plants.

The Counterpoise Hanger is a spring-actuated counterbalance. An ingenious system of linkage transforms the varying force of the spring in an accurate mathematical ratio to produce a load supporting effort of constant value throughout the entire range of expansion travel.

The design permits great flexibility of installation and saves valuable space in congested areas. All parts are ruggedly made and have a high safety factor, yet excess weight and oversize physical dimensions have been avoided to hold space and structural load requirements to a minimum.

The Navco Counterpoise Hanger is available in 16 different frame sizes with load capacities ranging from 200 to 16,000 pounds and expansion travels up to 12 inches. For detailed information on how you can get dependable support with this unique hanger, write today for our 12-page illustrated bulletin #153.



Note above how the flexible top connection permits the hanger assembly to fall in line with the direction of the load pull, so that horizontal travel of the piping has no appreciable effect on the hanger operation. The unit may be positioned at any angle. This affords flexibility in installations where close clearances are a factor.

** Counterpoise is a trade name of the National Valve & Manufacturing Company*

NAVCO

NATIONAL VALVE & MANUFACTURING COMPANY

3105 LIBERTY AVENUE, PITTSBURGH 1, PENNSYLVANIA

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This

NEW BULLETIN

provides economical solutions to every industrial water treatment problem

ENGINEERS and consultants helped prepare this new Bulletin No. 953 . . . "Controlled Volume Pumps for Water Treating Systems."

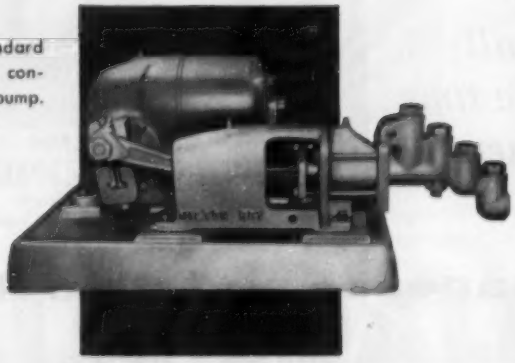
It has been termed, "a most important contribution to water treating literature."

Over fifty illustrations are used in this first-of-its-kind Bulletin, to describe and picture:

- Controlled Volume Pumps and how they work.
- Actual applications in all phases of industrial water treating.
- Basic and advanced system design.

Send for your free copy today . . . on your company letterhead, please!

For specific recommendations on water treatment problems, see your consulting specialist. For reliable, accurate flow control of water treating chemicals, see Milton Roy Company, Manufacturing Engineers, 1300 East Mermaid Lane, Philadelphia 18, Pa.



Milton Roy standard motor-driven controlled volume pump.

milton Roy
CHEMICAL FEED SYSTEMS

Engineering representatives in the United States, Canada, Mexico, Europe, Asia, South America, and Africa.

What are the men doing?

They are retubing the fuel economizer.

What happened to the old tubes?

Sulphuric acid ate holes in them.

Who put sulphuric acid in the fuel economizer?

Well, nobody meant to. But there was too much sulphur in the coal and when the coal burned some of the sulphur was turned to sulphuric acid.

Why did they purchase the high sulphur coal?

It figured out cheaper on the cents-per-million-BTU basis.

But was it really cheaper by the time they put the new tubes in?

No, it wasn't! And this instance shows that BTU cost is not the only factor to be considered in buying fuel. It's a matter of matching fuel to use and to equipment, and that requires close cooperation between the plant engineer and the purchasing agent.

P.S.

There's a lot more to buying coal than the cost per ton. For facts and figures to solve your particular fuel requirements, write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake & Ohio Railway Company, Terminal Tower, Cleveland 1, Ohio.

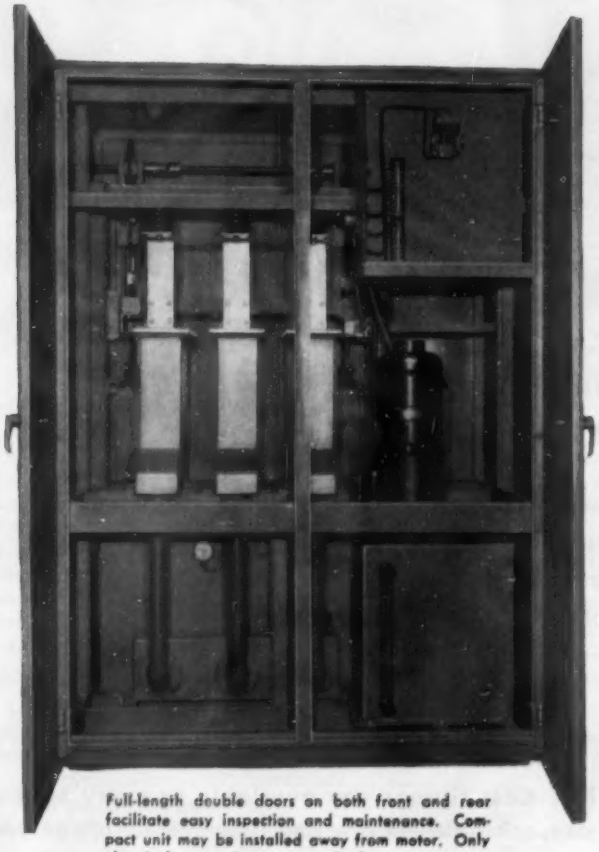
Chesapeake and Ohio Railway

WORLD'S LARGEST CARRIER OF BITUMINOUS COAL

ALLIS-CHALMERS
Liquid Rheostat
BOILER DRAFT
FAN CONTROL

New on the outside...

New on the inside



Full-length double doors on both front and rear facilitate easy inspection and maintenance. Compact unit may be installed away from motor. Only electrical connections are required.

Just about all that remains unchanged in this new unit is its basic time-proved principle . . . a design that provides a wide resistance range with short electrode travel. This gives the smooth, accurate speed control you are looking for.

Modern in performance . . . in appearance

The Allis-Chalmers liquid rheostat is now available in an attractive, safe, clean enclosure. And under its streamlined exterior are many engineering and construction improvements that assure better performance and lower operating and maintenance costs. For example: Individual cells are now constructed of steel for greater mechanical rigidity and protection against accidental damage. Cell linings are of thick, bonded rubber for maximum electrical isolation.

Long-lasting electrodes — removable tips

Electrodes are built up of cupronickel plates. Because this copper alloy is exceptionally resistant to corrosive and electrolysis action, replacement frequency is greatly reduced. If replacement becomes necessary, only removable tips need be renewed.

Low maintenance pump

Electrolyte pump is of the submerged sump type. No packings to be replaced.

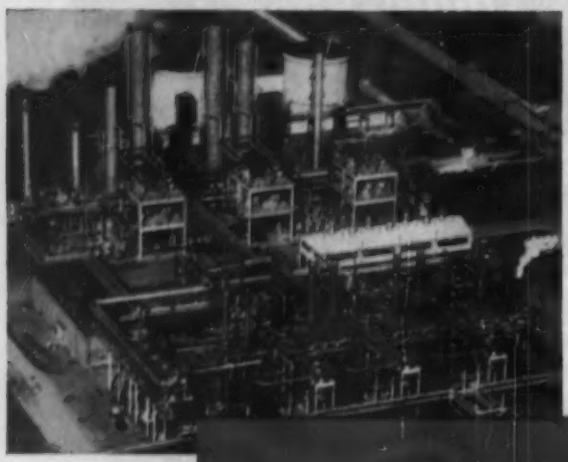
For complete information, see your A-C representative or write Allis-Chalmers, Milwaukee 1, Wisconsin for Bulletin 14B8231.

A-4578

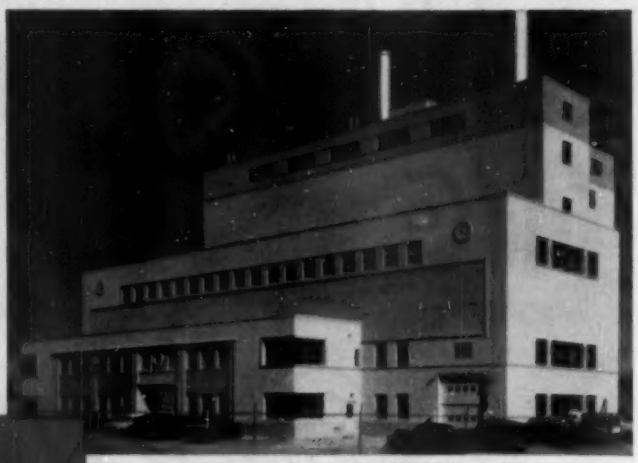
ALLIS-CHALMERS

A-C ALLIS-CHALMERS

for PETROCHEMICALS or POWER



Sun Oil Company petrochemical plant, Marcus Hook Pennsylvania



Power plant, Colorado Springs Department of Public Utilities

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Welding Fittings

Can Add Higher Strength at Lower Cost to Your Alloy Piping System

Whether your product is petrochemicals . . . power . . . or anything else requiring an alloy piping system, an investment in Key-Kast fittings can add higher strength and longer life to that system—and at a real economy, too. Here's why:

- Greater wall thickness throughout—for increased structural strength
- Extra thickness in critical areas—for greater allowance against erosion
- Lower unit cost
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- Rigid testing and inspection assure adherence to high standards of quality.

Key-Kast fittings are available in every shape, size, schedule—in low and intermediate alloys and various stainless steels

key company

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How to Select an Economical Temperature Regulator

First of all, what does economy mean where temperature regulators are concerned? In some industries it means improvement of product or reduction of spoilage through closer control of process temperatures. In others, it means the paring down of operating expense. The price of the regulator itself is a relatively small factor.

Today's buyers are shopping for:

1. Accuracy of control — not only when the regulator is new, but throughout its service life
2. Dependability — to prevent loss of production time
3. Minimum installation and maintenance cost

Here are a few tips on what to look for when you're installing a new or replacing an old temperature regulator —

Packless construction . . . and for this reason: A diaphragm operated, packless regulator minimizes friction. There are no closely fitted parts to stick or bind because of uneven expansion or collection of foreign matter. Also, there's less maintenance, since no repacking is ever required.

A guarantee against wire drawing of the seats and discs. Insist on it. This guarantee in combination with single seat design assures you of tight shutoff; you avoid expensive steam losses as well as loss of product in a process application.

Broad control range. In a standard regulator you should expect a control range of 100 F. And make sure the unit you select has a vapor tension thermostat that can take over-temperatures of at least 100 F.

Easy maintenance. Why ask for grief? Your temperature regulator should be basically simple in design so that it can be serviced by average plant personnel. All parts should be readily accessible for testing and cleaning.

Double duty. There's no point in buying a separate pressure regulator when you can select a temperature regulator that combines both temperature and pressure control within the same unit.

Self-operating. Make sure you get a regulator that operates on its own initial pressure. By doing so, you avoid the purchasing and maintenance of an air compressor plus air piping, and you're sure of uninterrupted operation during electric power failures.

• • • •

All of these points are important to you when it comes to selecting an economical temperature regulator. Perhaps you didn't realize you could expect so much. And perhaps you didn't realize that Spence Temperature Regulators offer all these features and more. May we send you our Bulletin T500 containing further details? SE 100

SPENCE ENGINEERING COMPANY, INC.
Walden, New York

AN IMPORTANT MESSAGE CONCERNING...

A Basic Advance In Motor Insulation

ELECTRIC motor and generator insulation has come in for its share of announcements of "new" and "revolutionary" developments. But in spite of these announcements, inherent shortcomings of conventional insulation have remained.

There has been little basic improvement in motor insulating systems . . . UNTIL NOW.

Allis-Chalmers, working with engineers and scientists of Dow Corning Corporation, has developed *Silco-Flex* motor insulation . . . truly new in concept . . . truly new in effectiveness.

The *Silco-Flex* insulation system employs a pure silicone rubber combined with specially developed application techniques to produce an insulation unmatched by any other in use today. Outstanding improvements are shown in all these important characteristics:

Homogeneity — The complete *Silco-Flex* coil insulation is vulcanized into a single piece with no joints, voids or splices which can develop into breaks in the insulation. Even the best of the new conventional insulations combine several dissimilar materials which are held together by binders.

Heat Resistance—The excellent dielectric and mechanical properties in silicone rubber do not change significantly with aging at high temperatures over long periods of time.

Moisture Resistance—Completely sealed, *Silco-Flex* insulated coils are the most moisture-resistant coils ever produced.

Chemical Inertness — *Silco-Flex* insulation has outstanding resistance to most atmospheric contaminants, corona and weathering. It also withstands weak acids, alkalies and lubricants.

Flexibility and Resilience — *Silco-Flex* insulation remains flexible and resilient indefinitely under operating conditions. It is especially resistant to mechanical abuse and to the stresses brought about by overloading and rapid starting and stopping. It is also amazingly resistant to abrasion.

Heat Dissipation — Most electric insulators, unfortunately, are also heat insulators. *Silco-Flex* insulation, by comparison, is an excellent heat conductor and materially assists in removing heat from the coils.

What Are the Benefits?

The characteristics of this new insulation are so remarkable that complete reappraisal of motor application practices and motor performance is indicated.

In *all* applications, the chemical, mechanical and electrical properties of *Silco-Flex* insulation insure increased service reliability and longer life.

In addition, this new insulation system may reduce or eliminate the need for special motor enclosures. Atmospheres contaminated with cinders and fly ash, for instance, will have little effect on *Silco-Flex* insulated windings. Similarly, abrasive dusts in steel mills will not harm this insulation. Savings through the use of open, instead of totally-enclosed, frames will also be possible in chemical, paper, food and other industries where water or corrosive atmospheres are a problem.

What About Availability?

New *Silco-Flex* insulation is immediately available for all Class H form-wound coils and for Class A and B windings. operating under selected service conditions.

For complete information on SILCO-FLEX ***insulated motors, see your Allis-Chalmers representative or write Allis-Chalmers, Milwaukee 1, Wisconsin.*** A-4684

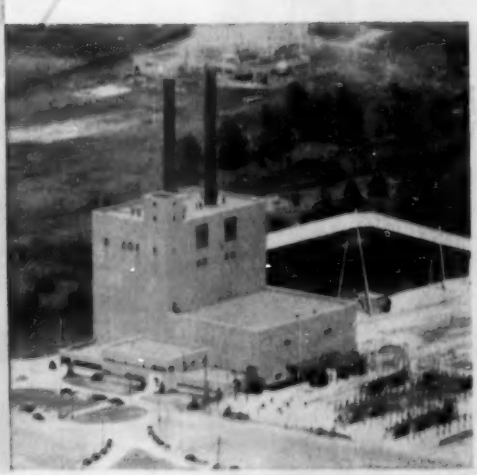
Silco-Flex is an Allis-Chalmers trademark.

ALLIS-CHALMERS

R. E. Burger Plant, Belmont County, Ohio
Present capacity: 270,000 KW
Scheduled capacity: 500,000 KW

Oh, I see

. . . they're using OIC Valves at Ohio Edison Company



Niles Plant at Niles, Ohio
Capacity: 212,000 KW

Postwar use of electricity has grown tremendously in the area served by the Ohio Edison System. New facilities added in the last 9 years have more than doubled total generating capacity. The Niles, Ohio, plant is completed, but expansion is still under way at the R. E. Burger plant.

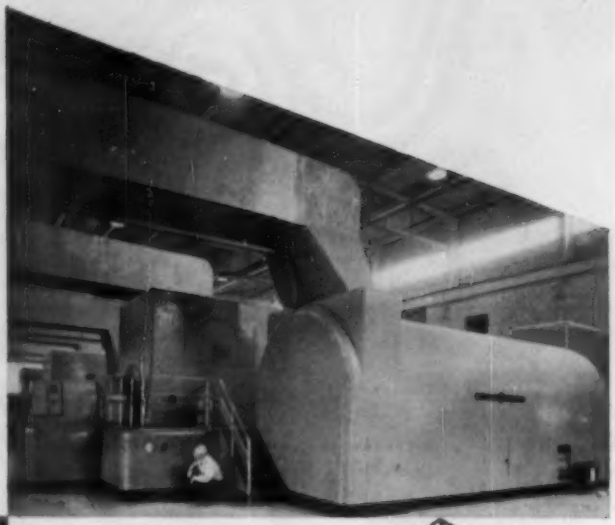
Thousands of OIC Valves are used in these plants.

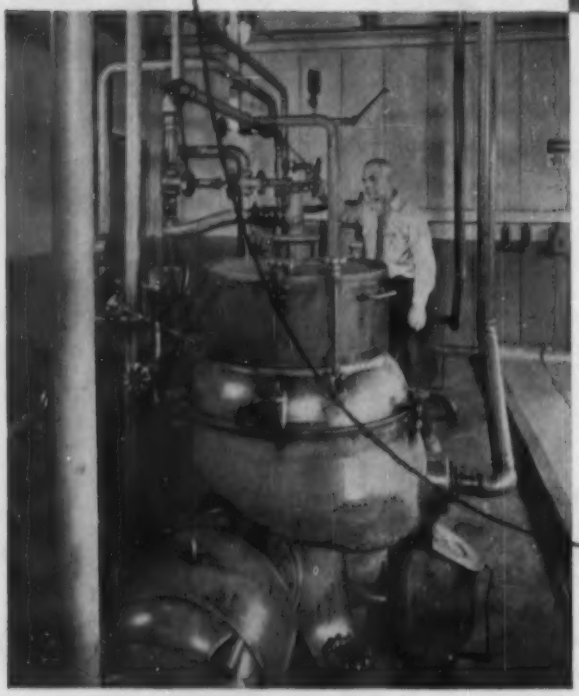
The OIC Long Line of Valves includes forged and cast steel, brass and iron valves. All are engineered and built to give long, trouble-free service. For a free copy of the OIC Catalog Digest listing these valves for quick reference, ask for Form 197.

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

BRONZE & IRON, FORGED & CAST STEEL,
LUBRICATED PLUG VALVES

15,000 kw. Gas Turbine Plant SAVES over $60.00 on Fuel per Hour of Operation!





The Rutland Plant of the Central Vermont Public Service Corporation has three 5000 kw. gas turbines . . . designed to burn low cost #6 Residual fuel oil.

BUT . . . ash deposit from the #6 fuel fouled turbine blading and nozzle ports . . . caused shutdowns . . . threatened to destroy parts of turbine by corrosion. Temporarily, the plant changed to costlier #2 distillate fuel.

Then technicians from the turbine manufacturer and from De Laval got on the job. It took work and engineering know-how to lick the problem. Solution? . . . a system of washing out the sodium and inhibiting the vanadium with *De Laval "Nozzle-Matic"* Continuous-Discharge Self-Cleaning Heavy Fuel Oil Purifiers* capable of handling 45,000 gallons a day!

Mr. Norton M. Cobb, Plant Superintendent says: "To illustrate what the De Laval Centrifugal Washing System has done for us, let's take a look at the possible savings for oil alone . . . $60.00 per hour when all three units are on the line . . . this makes the original cost of the equipment seem incidental . . . After burning more than 3,000,000 gallons of washed fuel, we have noticed no appreciable loss of power due to ash build-up and no visible signs of corrosion. We are well satisfied with our washing installation."

A complete report on the "Rutland Case" is available. Write for it.

*Trade mark reg.

DE LAVAL

heavy fuel oil purifiers

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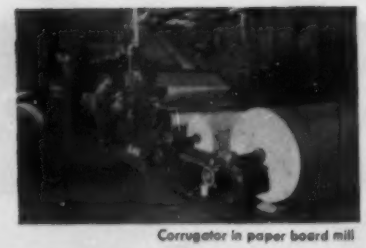
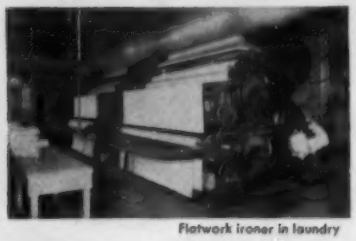


Corrugator in paper board mill



Flatwork ironer in laundry

Felt dryers in textile plant

Production UP 30%
Steam costs DOWN 40%

You may not believe it . . . but we'll prove it!

When a prominent chemical manufacturer installed a Cochrane C-B System on a dryer for titanium dioxide, production went from 45 to 65 tons per day—*a gain of 30%*. Steam consumption decreased from 12,000 to 7,000 lbs./hr.—*reducing steam cost 40%!*

This example is not unusual. In process industries, paper board mills, laundries, or wherever steam is used for heat transfer, over 2000 Cochrane C-B Systems are setting new standards of production. Higher output, improved product quality, unbelievably improved equipment performance, longer service life, fuel savings, reduced maintenance . . . these are the benefits a Cochrane C-B System gives you. They all add up to increased production efficiency—a vital factor in insuring your share of today's competitive markets.

Unless your condensate drainage is handled by a C-B "Closed System", it is almost certain that your steam and heat transfer equipment is *not* operating at maximum efficiency. By draining condensate at jet speed, the C-B System assures faster, more uniform heat transfer in both old and new equipment and gives outstanding savings by discharging steam at higher temperatures directly to the boilers or the make-up facilities.

You may still be skeptical . . . but these are facts and *these results mean money in your pocket.* So, why not spend a few minutes to find out the complete story? Write us TODAY for Publication No. 6025 on C-B Condensate Drainage Control Systems.

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Atomic Revolution?

JUST WITHIN THE PAST MONTH, the Atomic Energy Commission has received license applications for five nuclear power plants of commercial size. This makes over 750,000 kw likely to go into operation by about 1960. At least that's the score as this is written.

No one has any illusions that these plants will be easy to build or that they will be economically competitive. But, with what seems like a rush after years of lab and pilot-plant work, we're seeing the start of a nuclear-power industry. And questions about which we've been speculating in a leisurely way suddenly seem urgent.

Are we on the verge of a revolution in the power field? Should owners worry about quick obsolescence of new plants? Will engineers have to learn entirely new methods of design, operation and maintenance? Do fuel suppliers face shrinking markets? What will happen to manufacturers of conventional types of power equipment?

Let's make no mistake about it—the atom is bringing far-reaching changes to the power field. To these changes all of us will have to adapt in some degree. But the key word is "adapt." A realistic look reveals that we face an evolution, not a revolution.

We can see this most clearly if we put things into true scale. From no commercial nuclear units to 750,000 kw is a tremendous jump. But by the time those 750,000 kw have been completed, we will have added some 40 million kw to the existing 105 million of central-station capacity. This capacity is doubling roughly every ten years. By even the most optimistic estimates of nuclear growth it will be years before nuclear plants take a significant share of the total.

Two additional factors point in the direction of evolution: (1) Interest now centers in central-station applications; we have no indication yet of the part nuclear power may play in the big and varied industrial and institutional power-service fields. (2) All present nuclear-plant designs involve much familiar equipment; the unique elements appear in heat-releasing and steam-making parts of the cycle.

We see, then, that nuclear development affects only part of a rapidly growing total. Because the whole power field is expanding we can look forward to many years of increasing demand for conventional types of equipment, for present fuels and for engineers skilled in today's methods.

If we are wise, we will use this time to assess the changes the atom will bring and to prepare ourselves for the necessary adjustments.

In many ways, we are in a period like that of the 1880s, when POWER had its beginnings. Then engineers were struggling to size up the future of central-station electricity, to prepare for its effects on their familiar ways of doing things. Through educational series and up-to-the-minute reporting of new developments, POWER editors helped to guide their readers through the transition to the age of electricity. Now, in the early dawn of the atomic age, today's editors are geared to perform the same vital service for farsighted power men.

"Our Welding Machines were repeatedly being shutdown . . *until we changed to Fusetron Fuses*"

"They eliminated production losses due to needless fuse blows."

"Our service shop is headquarters for the Detroit area of Fruehauf's operation. Trucks, tractors and trailers come in for repairs.

"As you know, motor carriers don't make money if they aren't hauling freight. It's our job to have the equipment rolling — and fast!

"But we were having trouble with shutdowns. Ordinary 60 ampere fuses were constantly blowing on our welding machines. We have 12 of these machines — that can be connected to 60 ampere switches located throughout the shop.

"Since many major repair jobs require welding, these shutdowns were really a serious problem for us.

"In an effort to avoid these shutdowns, we installed Fusetron fuses. Since changing, there hasn't been any needless fuse blowing on the welders. Fusetron fuses completely eliminated the trouble."

Clyde Parkins CHIEF ELECTRICIAN
Detroit Branch • Fruehauf Trailer Company, Detroit, Mich.

EVERYONE IN THE PLANT CAN BENEFIT BY USING FUSETRON *dual-element* FUSES.

FUSETRON is a trademark of the Bussmann Mfg. Co.

To Electrical and Safety Engineers
Fusetron Fuses Offer Maximum Safety

The 100,000 amp. interrupting rating of Fusetron fuses is apace with the high capacities of today's network systems — and they are adequately safe to meet future circuit growth.

Fusetron fuses reduce the expense of damaged equipment and the danger of fire and other hazards that can result from electrical faults because — they protect against short-circuits, harmful overloads and single phasing.

To Production Engineers
Fusetron Fuses Offer Increased Production

Down-time is reduced, because Fusetron fuses wipe out needless blows caused by harmless overloads or excessive heating of panels or switches.

HERE'S WHY FUSETRON FUSES GIVE ALL-PURPOSE PROTECTION

A fuse link combined with a thermal cutout — the result, a fuse with tremendous time-lag and much less electrical resistance and an interrupting rating in excess of 100,000 amps.

They have the same degree of Underwriters' Laboratories approval for both motor-running and circuit protection as the most expensive devices made.

Made to same dimensions as ordinary fuses, FUSETRON Fuses fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 ampere, both 250 and 600 volt types. Also in plug types for 125 volt circuits.

Their cost is surprisingly low.

Write for bulletin FIS.

To Maintenance Engineers
Fusetron Fuses Offer Savings in Time and Work

Once properly installed, Fusetron fuses require no periodic inspection or down-time necessary on mechanically operated devices.

They protect against irritating interruptions of regular maintenance caused by needless blows. Unnecessary repair work is reduced because — if trouble occurs, Fusetron fuses open and warn of danger before motors or equipment are damaged.

Panels and switches are protected against damage due to poor contact heating.

To Top Management
Fusetron Fuses Offer Reduced Costs

Fusetron fuses cut maintenance costs because they are maintenance free — they increase life of equipment by guarding against damage caused by electrical faults — and they lower production costs by eliminating shutdowns due to needless blows.

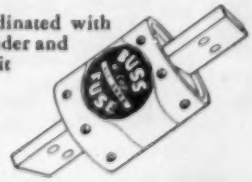
They save waste of space and money by permitting use of proper size panels and switches, instead of oversize.

FOR LOADS ABOVE 600 AND UP TO 5,000 AMPS . . . USE BUSS HI-CAP FUSES . . .

They have unlimited interrupting capacity to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuit of origin.

Write for bulletin HCS.



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***Play Safe!* install Fusetron and BUSS Hi-Cap Fuses throughout the entire Electrical System.**

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TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
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PP&E has established a wholly owned Canadian subsidiary at Hamilton to meet expanding requirements for high temperature, high pressure piping in Canada. Complete facilities for shop welded fabrication are now operating in the plant. Technical research and engineering services of our U. S. and Canadian plants will be interchanged—making available to all Pittsburgh Piping customers the broad practical experience and the advanced techniques that we have developed during more than half a century of producing piping systems for the world's greatest power plants.

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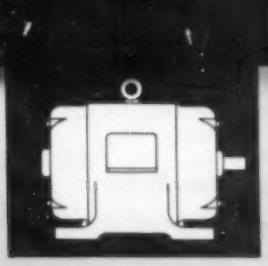


TODAY'S ELECTRIC

MOTORS

major key to modern industrial growth

By **JAMES J O'CONNOR,** Managing Editor

Industry's foremost wheel turner, the electric motor, has always been a basic responsibility of power men. This concern is now even more significant since many of the recent motor-design changes directly affect unit selection, application and maintenance. Typical areas where major changes have occurred are in *enclosures, rerating* and *insulation:*

ENCLOSURES, given a new look, have tightened their skirts about the motor's innards—today's open motors are more enclosed than ever before. Weather-protected designs are making big gains in outdoor installations. "Specials" are cropping up for specific industries.

RERATING of motor frames means packing more horsepower into smaller packages. Example: Motor makers are now worrying through the wisdom of designing 75 hp into the same frame that boasted 7½ hp in 1903. Operation "squeeze" means the motor manufacturer now offers the same performance in smaller frames—and an all-round better product to boot.

INSULATION improvements have made possible many enclosure and rerating changes, and on their own merits are extending motor life. New insulations are coming in fast, each trying to raise present electrical, mechanical and thermal limits, while reducing insulation bulk. Keep your eye on the epoxy resins and the isocyanates; they're showing promise as motor insulations.

Following 31 pages carry the boiled-down story of these changes, plus a close look at the many types of motors available, and what makes them tick. A careful reading of the full report will pay dividends for all power men. But for those close to recent motor changes, and for those who want but a preliminary trip through the report at this time, scan the illustrations, read the headlines and the underlined text.

a **Power** special report

June 1955

TYLER HICKS, *Associate Editor in Charge*

MECHANICAL FEATURES provide the structure, rotating means, insulation

1 Enclosures

Open	Totally enclosed
Drippproof	Nonventilated
Splashproof	Fan-cooled
Semiguarded	Explosionproof
Guarded	Waterproof
Drippproof, fully guarded	Pipe-vented
Externally vented	Watercooled
Pipe-vented	Air-to-air cooled
Weather-protected	Fan-cooled, guarded

See p 76-77

2 Bearings and lubrication

Bearing types	Lubrication method
Sliding contact:	Prelubricated:
Journal	Sealed
Guide	Field lubricated:
Thrust	Shielded
Rolling contact:	Oilless
Ball	Lubricant:
Needle	Petroleum
Roller	Synthetic
	Oil
	Grease

See p 78-79

ELECTRICAL FEATURES hinge on motor's torque-producing characteristics

5 Motor types

Direct current	Alternating current
Shunt	Single phase
Series	Polyphase:
Compound	Squirrel-cage
Universal	Wound-rotor
	Synchronous

See p 98-101

See p 86-97

6 Motor performance

Electrical	Mechanical
Efficiency:	Horsepower
Low-load	Torque requirements:
Full-load	Starting
Power factor:	Running
Utility penalty	Speed:
Feeder loading	Multispeed
Rotation:	Constant
Unidirectional	Adjustable
Reversible	Varying

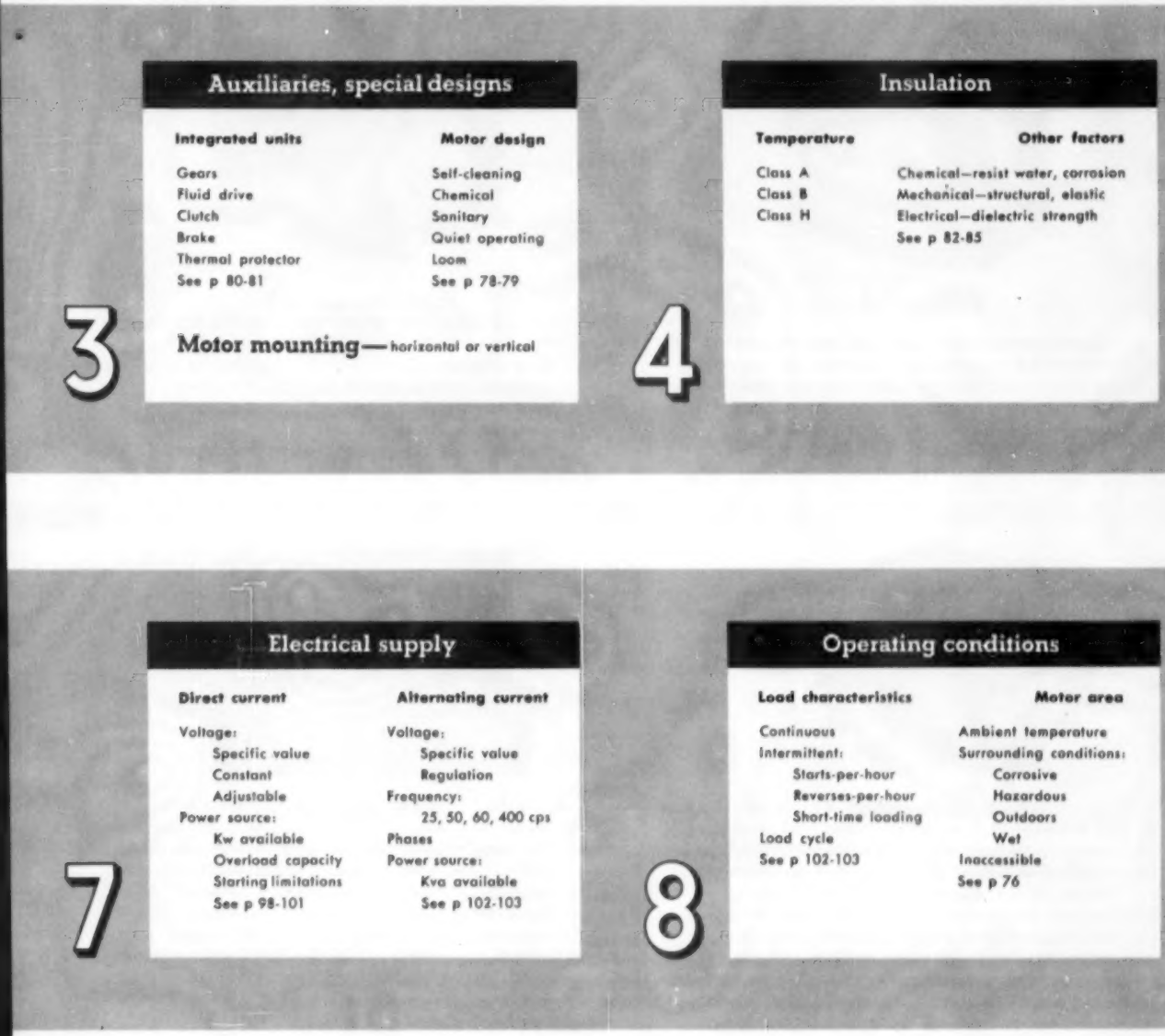
See p 86-101

MOTOR PANORAMA: your 8-point guide

Consider all these factors for a better understanding of today's electric motors. Numbered tabs on later pages relate to above. Example: 1 ENCLOSURES

There are many factors in selecting, applying and maintaining motors. Emphasis, however, is generally on one or two electrical requirements. Satisfying a motor's electrical needs assures you the unit will run. But mechanical considerations—enclosures, bearings and insulation—to a large extent determine just how long the motor will perform acceptably.

The recently publicized motor changes are essentially mechanical,



not electrical. So this report stresses these changes, rather than electrical phenomena met in operation.

The past 50 years have seen the electric motor take its place as the most widely used machine in industry. At the turn of the century, the dc motor was a practical and successful unit being applied in increasing numbers throughout industry, principally to replace the steam engine in driving line shafting and powering cranes.

Wide application of Nikola Tesla's induction motor (1888) had to await adoption of polyphase electrical distribution. Early systems were single phase, 133.3 cps—much too high a frequency to accomodate motors of practical construction for reasonable speeds.

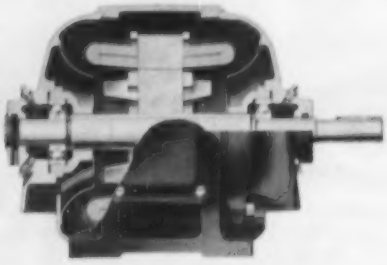
Electric motor industry has advanced far since the days of the first polyphase unit. Many of today's construction features—both protective enclosures, housing horsepowers ten times those formerly contained in a given frame, and the thin-skinned highly efficient insulation—were far beyond the horizon of early designers.

To fulfill our aim within 32 pages, we omit reference to some types of motors found in industry today. Typical are high-frequency units and fractional-hp motors. But the report's basic information applies to these units, as well as to those covered in detail.

OPEN

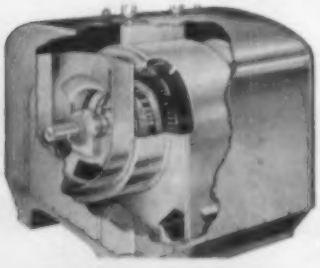
Dripproof

Least costly, suitable for clean indoor areas. NEMA-defined as one having vent openings so constructed that particles falling on machine at any angle, not greater than 15 deg from the vertical, cannot enter machine directly or by running on horizontal surfaces



Splashproof

For more protection, splashproof enclosure is designed so liquid drops or solid particles falling on the unit, coming toward it on a straight line, or at any angle not less than 100 deg from the vertical, cannot enter directly or by running along surfaces



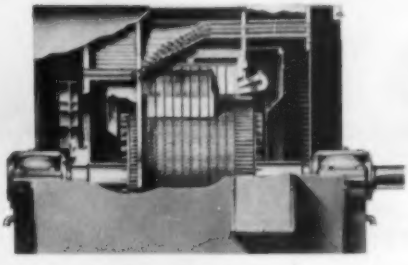
Weather-protected

This low-cost motor design has side openings through which air travels up into space above stator. Rotor fan draws air from this chamber through motor windings. Heated air discharges through stator vents. Units have been used down to −40 F with heaters in oil

TOTALLY ENCLOSED

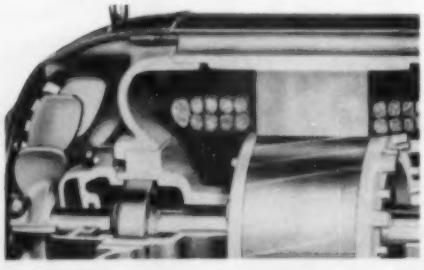
Pipe-ventilated

Totally enclosed except for inlet and outlet duct openings. Connecting ducts admit and discharge ventilating air, which is circulated by a fan within the motor enclosure or, in many cases, by an external blower. Applied if clean air is not available at motor proper



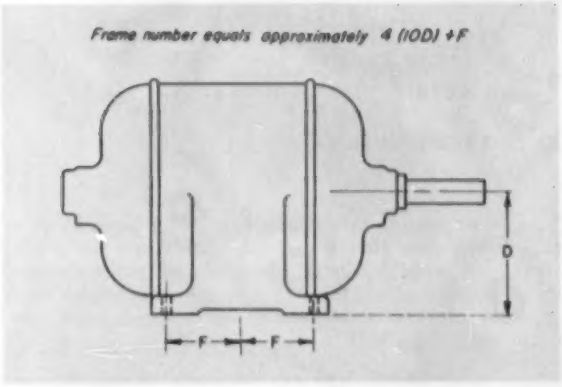
Fan cooled

This popular totally enclosed fan-cooled unit (TEFC) has a fan at end of motor shaft to circulate air around its totally enclosed motor frame. TEFC design is becoming increasingly popular in all sizes. Lower maintenance and greater reliability offset first cost



Explosionproof

Designed and constructed to withstand internal explosion of a specified gas or vapor and to prevent ignition of any gas or vapor surrounding motor. In applying explosionproof motors, refer to National Electrical Code, Article 500, for application data



NEMA FRAME NUMBER linked to motor dimensions shown. Precise value of *F* can be had by checking the numbering-system chart in NEMA's *MG 1-3.01*. Example: *D* value for 182 frame is 4½ in. *F* value is keyed to third digit in number; equals 2¼ in.

Motors now are more enclosed . . . some are designed for specific industries: textile, chemical, food . . . there's still difference of opinion on prelubricated sealed ball bearings, and . . .

Rerated motors are now catching on fast

All motors are either *open* or *totally enclosed*. *Open* designs have some form of enclosure, variation showing up in size, location and shape of vent openings. Dripproof, splashproof and weather-protected motors, *on facing page*, are among the more popular of the open types. Three *totally enclosed* designs of interest to power men are also illustrated.

For a complete listing of available enclosures for small motors, 200 hp and below, see National Electrical Manufacturers Association (NEMA) publication *MG 1-1955*. Also, check the handy reference table for large motor enclosures on p 102 of this report.

Your key to hazardous-area installations is the National Electrical Code (NEC), Chapter 5, Article 500. First get to know the potential danger of each vapor, dust or gas in your plant. Then classify them according to Section 5004 of NEC.

If an explosionproof enclosure is indicated, be prepared to pay more than twice the cost of a simple dripproof design. For large motors consider the pipe-ventilated (TEPV) enclosure as a dollar-saving substitute. They run about 25% above price of dripproof. TEPV's may be cooled by forced-air or water. Caution: Intake air must be free of hazardous gas or dust. In mildly hazardous and corrosive areas, many large slip-ring motors have been equipped with clean-air-purged slip-ring compartments.

Weather-protected designs stepped into the enclosure picture some years back as power men moved toward outdoor installation of motor-driven equipment. Totally enclosed motors could be used . . . but weather-protected units mean sizable savings in first cost, while protecting motor's innards from rain and snow. Typical applications: pumps, blowers, draft fans, crushers.

How reliable are weather-protected designs? One manufacturer has recorded several hundred thousand hp, installed since early 1948, without running into a single failure. In brief, these units are fast becoming the new standard for large installations.

Frame numbers. Over 80% of all motors now on the American market are made by 54 firms who are members of the Motor and Generator Section of NEMA. This group has a pattern for motor frame numbers to which all conform. This frame-number standardization is of material help to both user and maker. Right now an effort is being made to establish an international standard.

Note the significance of a NEMA frame number, *sketch above*. First two digits in the frame number equals four times the distance in inches from motor base to shaft center. Thus a 182-frame motor has its shaft center 18 ÷ 4, or 4½ in. above the base. Frame number's third digit pertains to distance from the motor's vertical center line (perpendicular to shaft) to bolt holes in motor feet. Precise value of this dimension, known as *F*, can be had by checking the numbering system chart in NEMA's *MG 1-3.01*. Example: The *F* value of a 182 frame is 2¼ in.

Back in 1929, NEMA members agreed to standardize motor frame sizes. Then for the first time, frame sizes were pegged to correspond with certain hp ratings. These values held tight till 1940. At that time some rerating was proposed and adopted for the larger frame sizes. It was not until 1953, however, that NEMA revised its earlier frame assignments for motors in the range of 1 to 30 hp.

Motor rerate program is still in the transition stage

Today's frames are being uprated to house more hp in a given frame size. How come? Big reasons are the availability of better insulations and lamination materials. Probe a little and you'll see that motor innards have been shrinking over the years, yet motor designers have held to the established NEMA frame sizes. Recent rerating excitement meant, in many cases, simply a reduction in waste space within an existing motor. In some frames, manufacturers are packing twice as much hp.

Motor insulation, in 1929, used much cotton-covered wire, paper, cotton slot and phase coverings. Impregnating varnishes used natural resins, oils and solvents. To get suitable dielectric strength, a considerable mass was used.

Today's insulations lean heavily on synthetic materials. And it means a big saving in space. Synthetic-resin wire coating is thinner than yesteryear's insulations, yet offers greater resistance to leakage. Synthetic insulations have found their way into slots, between phases and as lead protection, and are doing an all-round better job.

Better lamination materials in motors have trimmed back iron losses. Modern rerated motors operate at higher flux densities, meaning less iron is needed for any given hp.

Textile

Windings are coated to a smooth, hard finish so lint, dust will not adhere. Open end-bells assure free movement of air over stator coils in this motor

To you, rerating means stocking additional renewal parts and some additional motors during the transition period. Manufacturers now have transition motor bases on hand so an old motor can be replaced with a rerated unit without disturbing original fastening-bolt location or changing the distance from shaft center to base. Rerated motors are meeting the old performance standards.

Prelubricated sealed ball bearings remain a 2-sided question

Eliminating regreasing of rolling-contact bearings in motors is a natural step in the direction of making equipment maintenance-free. Today's sealed designs use a standard double-row bearing width, a single row of balls.

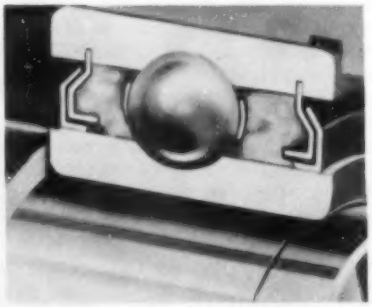
Rated same. Keep in mind that the prelubricated ball bearing does not differ fundamentally from the conventional open type. It is made from the same material, to the same specifications regarding tolerances and fits. It is rated to carry the same load and have the same life as its open twin.

First major motor application of prelubricated bearings came in the textile field. Aim was to lick the tough problem of protecting grease fittings or oil cups from oil-thirsty lint that settles in heavy layers on any surface wetted by oil.

Grease vs temperature. Type of grease used in prelube bearings depends on temperature conditions. Standard open motors are recommended for operation with bearing temperatures from −40 C to about 65 C (−40 to 150 F). This 65-C top temperature is a conservative value, not ultimate limit. This is especially so if high temperature is due to temporary or seasonal ambient conditions. Adverse effect of temperatures higher than recommended is gradual reduction in grease life. This life-shortening is stepped up as temperature increases.

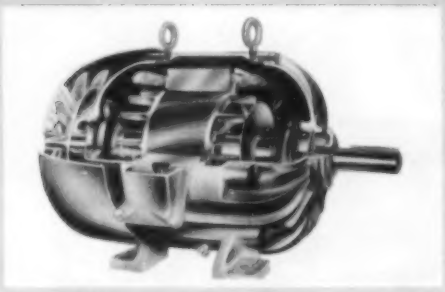
Where bearing temperatures are in excess of 65 C, silicone grease is used—up to 100 C (212 F). For still higher temperatures—up to 125 C (257 F)—the bearings themselves must be heat-stabilized during manufacture.

Loss of grease. Risk of losing the grease, and eventually the bearing, from grease leakage through seals, is a point raised in the past. This has not been a problem, even where the bearing operates in a high-temperature area, which makes the grease more fluid. You can understand this by looking at the melting and dropping point of any good grade of commercial grease. These points usually run anywhere from 350 to 480 F.



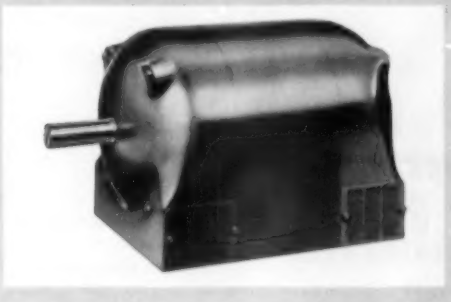
PRELUBRICATED design uses 4-way seals; in effect, two seals on each side of the bearing. Cannot be regreased in field

Four-way seals used by prelubricated bearing manufacturers today,



Chemical

Cast iron, stainless steel, offers top corrosion resistance. Self-cleaning effect of air stream reduces maintenance. External fan is aluminum

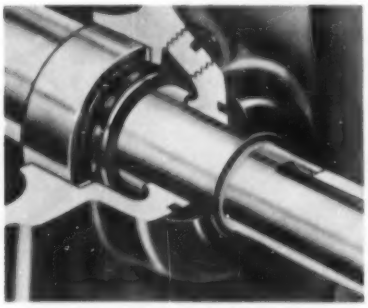


Sanitary

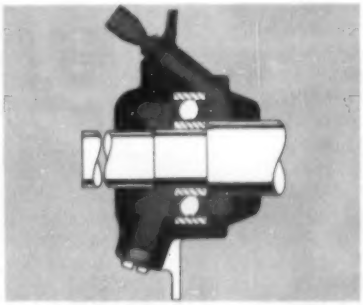
A splashproof, verminproof, streamlined motor designed for the food and beverage industry; no crevices where food particles could collect

Standards. Most manufacturers at present are making motors to both the old and new standards. They look to eventual adoption of the rerated motor across the board. We are not listing here the actual frame numbers of rerated motors since they have already been tabulated in the literature of practically all motor manufacturers. In general, rerating has affected frame sizes from 182 to 326.

Industrial enclosures, *illustated above,* are typical of the steps motor manufacturers are taking to tailor-make a product for a specific industry. The textile group is a good example. Right now they are fighting the lint problem with totally enclosed nonventilated designs (TENV) in smaller ratings. For larger ratings, many plants now use *textile* motors designed so lint passes through.



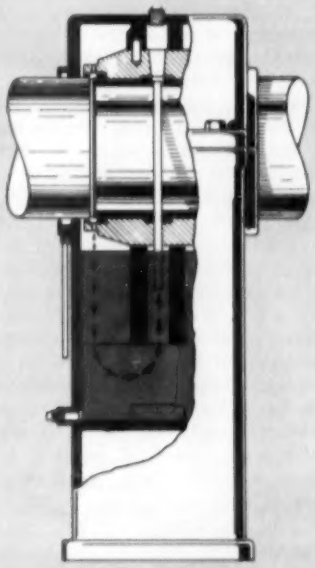
LABYRINTH SEAL on motor shaft prevents entry of dirt into the bearing housing. This design permits regreasing in field



LUBE PATH in this setup is such that regreasing actually forces new lubricant through ball race, replacing old grease

sketch above, have two seals on each side of the bearing; a total of four. The inner seal is attached to the outer bearing race and is stationary. The outer seal is attached to the inner bearing race and rotates. Note that these are true grease seals, not simple shields.

Not all motor manufacturers agree on the use of prelubricated sealed bearings. Some feel the answer lies in designing a bearing housing that holds a large grease supply with provision for regreasing, if and when necessary. Some plant engineers insist on prelube bearings for motors in out-of-the-way places where lubrication at best may be hit or miss. But they like the reassurance of being able to regrease motors that are in accessible places.



One-to-one bearing

Typical sliding-contact bearing for large motor. Modern one-to-one ratio of diameter to length; bearing is of babbitt. Oil ring directs circulation of the lube

Integral auxiliaries

Here are but three examples of the packaging trend among motor makers

The ac polyphase induction motor is used in nine out of ten of today's industrial applications. In the induction-motor group are the squirrel-cage, wound-rotor and adjustable-speed commutator design. Squirrel-cage, the granddaddy, is the most widely used.

Motor manufacturers now incorporate power-transmission units in the frames of many motors. Typical are the gearmotor and fluid-drive motor. Although a brake is not a power-transmission unit, we are including the brake-motor in the same general classification.

Gearmotor popularity hinges on the fact that cost and size of electric motors increase considerably as speed for any given hp decreases. It's generally most economical to reach lower driver speeds through use of a standard 1750-rpm motor, with its output speed trimmed down.

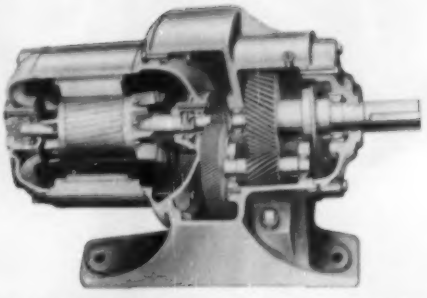
Covering a hp range anywhere between ⅛ and 200, many gearmotors are designed for output speeds from 5⅞₀ to 780 rpm. Where the driven speed is 900, 1200 or 1800 rpm synchronous, a motor with 8, 6 or 4 poles may be used without a speed reducer. In the 700- to 900-rpm area, however, many power men prefer an 1800-rpm motor in combination with flat belts or V belts. At about 700 rpm and below, the practice is to use a chain drive, a belt, a separate gear reducer or, as is becoming increasingly popular, a gearmotor.

Selection of the right gearmotor boils down to choosing between one of three classes. Each gear class has different gear sizes and is equipped to handle different type loads. These classes are needed because overload on a gear is more critical than on a motor. Class I gearmotors have a gear rating at least equal to motor hp. Class II rating is at least 1.41 times motor hp. Class III has a gear rating two times the motor hp.

Fluid drives built into a motor-drive combination are proving an effective way af assuring smooth starts, easy acceleration, and protection of machine against shock of sudden starts. Loads, tough to bring up to speed, are accelerated easily with standard motors and fluid couplings.

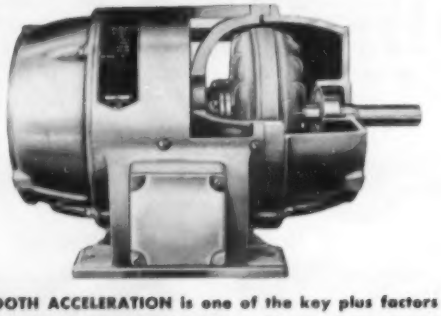
Brake-motor units are available to stop a load rapidly, even in less time than needed to reach top speed. Applications include hoists, cranes, elevators and many production machines.

GEARS



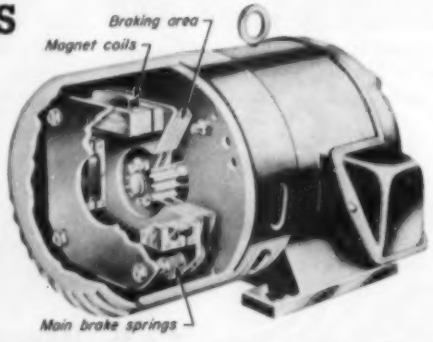
HELICAL GEAR-TRAIN of this unit operates in sealed compartment. Large main gear merely dips into lubricant, thus preventing excessive churning. Unit available from ⅓ to 30 hp, standard AGMA speeds from 4 to 10,000 rpm

FLUID DRIVES

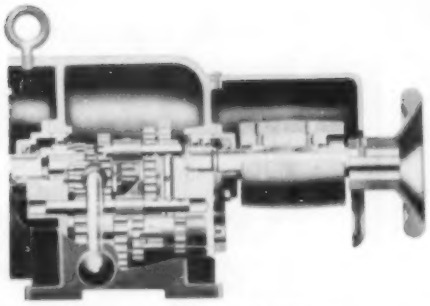


SMOOTH ACCELERATION is one of the key plus factors in fluid-drive motor combination. Above unit comes in ratings from ½ to 15 hp. Since starting overloads are cut, motor can be sized to match true operating-hp needs

BRAKES



WHEN BRAKE HOLDS, evenly spaced steel springs press nonrotating brake-lined plates against rotating metal disk on shaft assembly. Energizing motor releases brake through electromagnets, which overcome spring tension



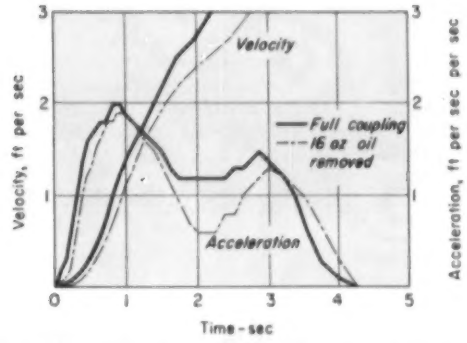
GEARSHIFT DRIVE is combination of 4-speed sliding-gear transmission and induction motor. Above unit available in ratings of ½ to 15 hp. Drives with single-speed motor have four output speeds; 2-speed motor gives eight

Tips on gearmotor selection

Since heavy overloads are more likely to cause failure of a gear than a motor, the gear is sized for maximum peak, not average loads. Selection boils down to checking the gearmotor manufacturer's handbook for the particular application, noting the hours of service required, and looking up the gearmotor recommended.

Many loads need a gearmotor one class larger for 24-hr-a-day service because wear on a gear running this period is three times what it would be for an 8-hr day. To meet this condition, a larger gear is used for 24-hr service. It is so sized that the wear per hr is reduced to about ⅓—giving the higher rated gear the same service life as an 8-hr unit.

Note: A gear running no-load half the time, 100% overload the remainder, far exceeds the *average* load.



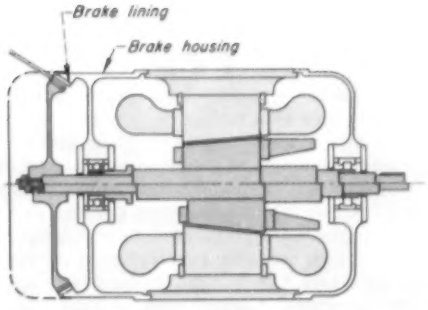
FLUID REMOVAL from coupling has above effect on operating characteristics. Unit is applied to 5-ton crane at 1800 rpm. Tests show that hoist equipped with 2-speed fluid drive compares favorably with a wound-rotor unit

Fluid-drive operating facts

Look upon the fluid coupling as a combination coupling and slipping clutch. Heart of the coupling is the oil-filled space between both coupling halves. Within the coupling are an impeller connected to the motor, and a runner connected to the load.

When motor starts, impeller turns, setting oil in motion. Centrifugal force moves oil away from the shaft against each set of adjacent impeller blades. After oil reaches outer side of coupling, it passes across the gap between impeller and runner. At this point it strikes runner blades.

Runner turns in same direction as impeller, but always at slightly lower speed. The lower speed means a difference in centrifugal force between impeller and runner. It keeps the oil moving in its orbit.



MAGNETIC PULL of stator on rotor compresses shaft spring, releases brake. Conical stator bore and rotor yield strong enough magnetic pull to release brake. When motor is deenergized, spring forces rotor back, applying brake

Typical brake-motor ratings

Brake unit, *illustrated on facing page*, is available with continuous torque ratings from 3 to 300 lbft. Intermittent torque values run between 5 and 450 lbft. Manufacturer supplies seven basic sizes for use with squirrel-cage, wound-rotor or dc motors, in standard frame sizes from 172 to 505.

It is interesting to note that series-wound dc brakes, when adjusted for maximum rated torque, will release at 40% of the full-load motor current. They will not set until the current drops to 10% of this full-load value. Use a shunt-wound brake if motor current goes below 10% of full-load amperage.

Series or shunt-wound brake operates satisfactorily with either a series, shunt or compound motor. Motors are available from ¼ to 100 hp.

Hold to these limits for long motor life

Class insulation of motor	Enclosure	Ambient, C	Temperature rise, C	Hot-spot allowance, C	Max. internal temp, C
A	Open	40	50	15	105
	Totally enclosed	40	55	10	105
B	Open	40	70	20	130
	Totally enclosed	40	75	15	130
H	Open	40	110	30	180
	Totally enclosed (fan-cooled)	40	115	25	180
	Totally enclosed (nonventilated)	40	115	25	180

Note: Class E and F insulations are being proposed as international standards (see p 85). If adopted maximum temperature for Class E will be 120 C; Class F will have a top temperature of 155 C

How insulation fails

Insulation seldom fails from immediate breakdown when some critical temperature is reached. Actually, thermal aging makes insulation vulnerable to failure from a number of causes. Typical among these are: (1) expansion and contraction stresses from relative movement of winding (2) mechanical vibration and shock (3) contaminated air, moisture (4) electrical stress. How high you can raise insulation temperature depends on how much life you expect to get from the motor. Insulation life halves for each 10-C rise.

Minimum insulation life can be determined by checking insulation resistance while winding is exposed to high humidity. During reliable winding life, insulation resistance remains fairly constant. When value shows a sudden downward trend, failure is approaching.

New insulations are key to smaller frames

Man-made molecules, formed into insulation, make big change in today's motor picture

In recent years hardly a month has gone by without some motor manufacturer announcing a change in either the materials or technique for insulating motors. When the change involved materials it generally meant adoption of glass, silicone, or other synthetic wire coatings in place of older materials. Aim in each case was to find an insulation that would withstand modern motor-operating conditions, yet carry a reasonable price tag.

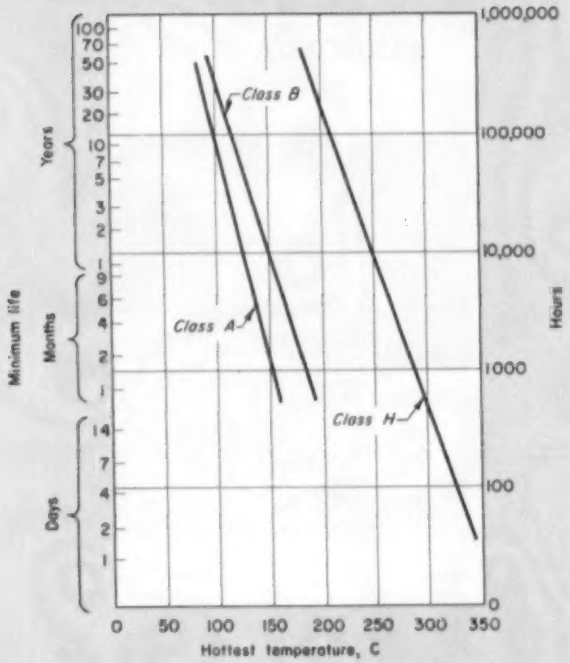
Insulating materials must meet basic electrical, mechanical, chemical and thermal requirements. *Electrically* the insulation must have a high dielectric strength per unit of thickness, low dielectric losses, high ionization and arc resistance. *Mechanically* it must be strong, pliable, workable, and yet withstand temperature changes and vibration. *Chemically* a prospective insulation must withstand moisture, oils, mild acids and alkalies. *Thermally* it must withstand established operating temperatures, as met in everyday practice, without decomposing.

Early thinking established temperature as an insulation's classifying index. In those days no synthetic materials were available; what was available readily fell into two classifications: *organic* and *inorganic*. Most wire enamels are organic, while mica, asbestos and glass are inorganic. This early classification developed into present NEMA standard classifications: Class A, B and H.

Class A ingredients are varnish-impregnated cotton, silk and paper. It may also be a molded or laminated material with a cellulose filler, phenolic resins or others with similar properties. Films and sheets of cellulose acetate and other cellulose derivatives are in this same grouping. Varnishes (enamels) applied directly to conductors are also in Class A. They are currently being re-evaluated for possible shift to Class B or H if they meet the temperature requirements.

Widest use for Class A is in small and medium motors. Minimum life expectancy is seven years at 105 C.

Class B includes mica, asbestos and glass fibers in built-up form with organic binding substances. A small amount of Class-A material may be used for structural purposes. But where used, the electrical and mechanical properties of



INSULATION LIFE relates directly to working temperature. As a rule, the life expectancy is halved for each 10-C rise

and longer life

the insulation must not be damaged when the temperature reaches the top value allowed Class B.

Use of Class B is growing in large motors and among specials, such as railway and steel-mill motors. Life expectancy is seven years at 130 C.

Class H is the newcomer. It's simply Class B with a binder of silicone compounds or other materials with equivalent properties. Also, it may take the form of silicone compounds or similar materials in rubbery or resinous form. (*See silicone rubber on form-wound coils, p 85*). Synthetic materials like dacron and Mylar are now being tried as electrical insulators.

Allowable hottest-spot temperature for Class H is 180 C, so naturally it is finding more applications in jobs involving high ambient temperatures and extreme duty cycles or load conditions. What life can be expected? Tests indicate at least seven years of continuous operation at hottest-spot temperature of 220 C is needed to reach minimum thermal life. At the more modest level of 180 C, test data indicate life expectancy of 60 years.

Hottest-spot temperature mentioned above is actually the sum of three figures: (1) The *ambient temperature*, which is the air temperature immediately surrounding the motor. (2) The *temperature rise* (number of degrees the hottest

Here are the new insulations showing promise

ON THE WIRE

Right now, many of the country's top insulation engineers are bringing to motor manufacturers new wire coatings that show exciting promise. But they must first be thoroughly tested. Coatings that today show most favorable characteristics are *epoxy, polyester, isocyanate and triallyl cyanurate resins.*

Epoxy resins, with us for some 10 years, have solved many knotty problems in industry. Sometimes labeled ethoxylene resins, they are used in a new breed of glues and are a prime ingredient in making home washers stand up under the daily onslaught of detergents.

Now the epoxies have found their berth as electrical insulators. Today, they are used in transistors, selenium rectifiers, capacitors and motors (see POWER, Nov 1954, p 122). The epoxy family is a class of materials made up of carbon, hydrogen and oxygen.

Epoxy wire coatings have been under critical tests for several years. Results show the material has a high resistance to heat, water, water vapor and Freon compounds. After further testing, the epoxy materials may become standard for certain motors.

One serious disadvantage has loomed for the high-percentage (88%) epoxy compounds; aging characteristic or shelf life must be improved. The high-percentage epoxy, used as a wire coating, shows signs of embrittlement when allowed to stand on a warehouse reel six to ten weeks. This factor could well lead to faults when wire is formed into coils.

ON THE COIL

New slot and phase insulation materials have appeared in recent years. One receiving much attention is Mylar (polyethylene terephthalate), which boasts an unusually high dielectric strength in thin films. It has a major drawback, however; it reacts with water to form organic acids, which reduce the dielectric strength.

But the problem is being solved by laminating the Mylar between sheets of rag-base or kraft paper. In some cases, asbestos paper, glass-fiber mat or glass cloth have been successfully used. When a finished winding is dipped and baked, the impregnating resin forms a hermetic seal around the Mylar.

INSULATING VARNISH

Experience proves that phenolic resins maintain a consistently high dielectric strength, yet resist common contaminants. But they are subject to early aging and embrittlement. When phenolics are combined with alkyd resins, a varnish with long thermal life, not susceptible to embrittlement, may result. The alkyd resins have proven their worth over the years, are best known in the industry as Glyptal.

Varnishes composed of epoxies, epoxy-alkyds, ester gums, polyesters and polyvinyls all play their role as specialized compounds for specific jobs.

Will Class H pay off in your plant?

The coming of Class-H insulation emphasizes resistance to high temperature. This is mighty important, but remember a good insulation must possess other qualities, as outlined on pp 82-83.

Class H takes the spotlight where (1) high operating or ambient temperatures can't be avoided, (2) overloads are responsible for frequent outages (3) high ambients limit life of Class A or B motors (4) rapid reversing causes frequent and premature failure (5) excessive moisture is present and (6) cost of down-time is prohibitive. Yet many of the above Class-H applications are like human use of miracle drugs. When trouble symptoms flare, we turn to them for help—and they do a good job. But many times, advance planning would keep the emergency from occurring in the first place.

Full temperature advantage of Class H is, in general, realized only when space is at a premium or ambient conditions largely dictate the operating temperature. Keep in mind that it is not only insulation that must stand high temperatures—bearings and lubricants must also. And silicone lubricants are likely to come to the rescue here.

RANDOM-WOUND

HAND WINDING is still the practice. But coils are shaped by machine beforehand

part of the winding, which can be reached for temperature measurement, rises above ambient). This is the temperature rating generally stamped on motor nameplate. (3) *Hot-spot allowance* is the difference that can be expected between hottest inaccessible part of the motor winding and the hottest accessible spot. The table, *p 82*, shows the temperature values corresponding to these terms.

Proper classification of many synthetic insulations is a current problem because temperature alone is an inadequate index. Temperature is but one factor; electrical, mechanical, thermal properties are important too.

Motor windings may be classified as either *random-wound* or *form-wound*. Wire in a random-wound motor is wound into the slots without regard to relative position of turns, *photo above*. Winding becomes a collection of turns without clear separation into layers. A form-wound unit, however, has its turns wound into precise layers with each in a definite position. Random winding is generally confined to the motors in the 100-hp and smaller range.

Defining the two forms of winding leads to the next logical step—classifying different insulations found in motors. Motor insulations fall into one of three groups: (1) primary insulating coating on the conductor (2) slot and coil insulation (3) impregnating resins and enamels.

New wire-coatings for random-wound motors meet Class B, maybe H, temperature requirements

Primary insulating coating is designed simply to insulate adjacent strands or loops from each other. It is not intended to insulate the winding from its surroundings; that's where slot-and-coil insulation comes in.

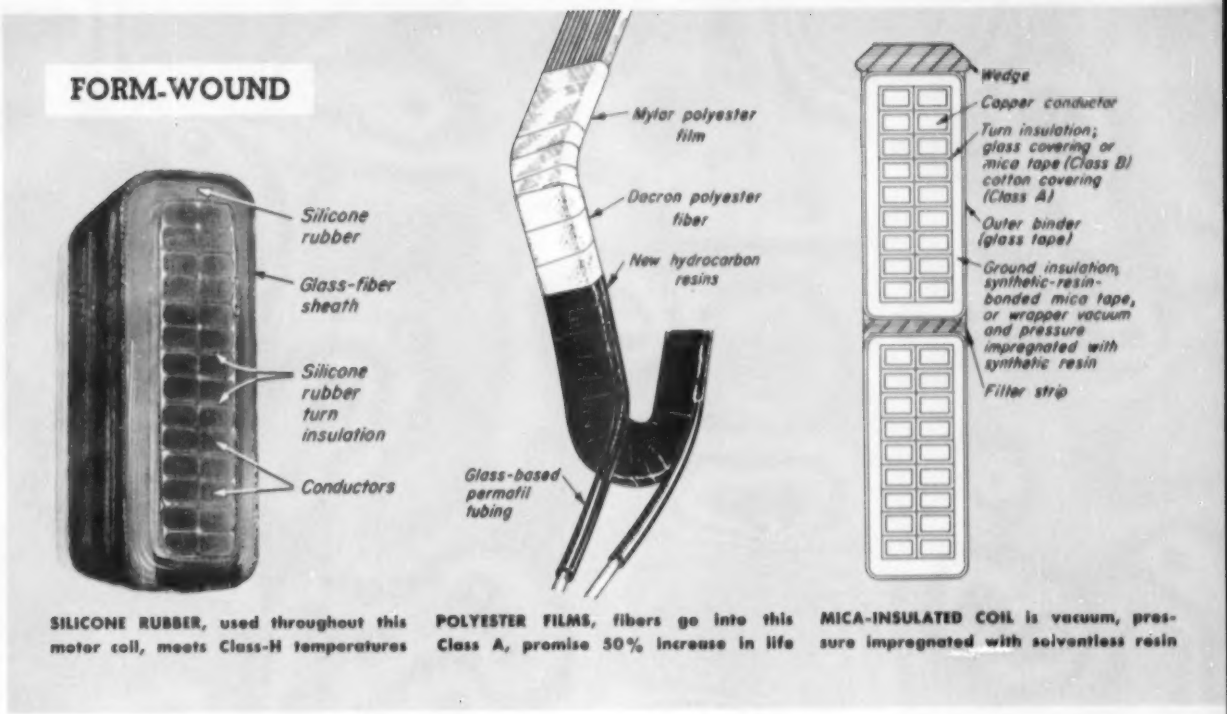
Now let's look into the makeup of three differently insulated form-wound coils being supplied by motor makers, *shown on facing page*.

Silicone rubber as a complete insulation system has just been announced by one manufacturer. Material is applied to the entire coil structure and then vulcanized to form a homogeneous void-free dielectric barrier. Built-up layers of dissimilar materials and binders are eliminated. Test data show silicone rubber in this application has a loss factor of about 0.0005 at temperatures ranging from 0 to 200 C. Dielectric constant decreases gradually from 3.2 at 0 to 2.2 at 250 C. Dielectric strength remains essentially constant over the entire temperature span from 0 to 250 C. A sample of silicone rubber, 0.074 mils thick, was aged eight weeks at 250 C yet retained a dielectric strength of 500 volts per mil after flexing.

Since this insulation system is a homogeneous void-free barrier, the maufacturer claims carbon black, metal particles, cement and other contaminants cannot penetrate the windings to cause premature failure. Right now, large motors in the 2.3- and 4-kv class are being built with this insulation system. Higher voltage windings are expected soon. Price will be on a par with previous Class-H.

Polyester film and a synthetic hydrocarbon resin go into the homogeneous insulating structure of another system, *facing page*. It is a Class-A insulation that is now being used to insulate form-wound coils of induction motors from 100 to 3000 hp. Plans are under way to extend this insulation system to even larger motors.

The polyester film insulation system eliminates cotton



SILICONE RUBBER, used throughout this motor coil, meets Class-H temperatures

POLYESTER FILMS, fibers go into this Class A, promise 50% increase in life

MICA-INSULATED COIL is vacuum, pressure impregnated with solventless resin

and paper-base materials—which have no insulating qualities anyway. In their place, materials are used that are insulators in their own right. Like the other systems, this choice of materials and technique permits packing more hp into a given frame size, and at no extra cost to the user.

Mica insulation is the base for another popular form-wound system. Here, large mica splittings are bonded either into a tape or wrapper with a synthetic resin. Then the complete coil is vacuum- and pressure-impregnated with a solventless heat-reactive synthetic resin. It is cured at elevated temperature. This impregnation process produces an insulating system that is completely void-free.

In a test run, stator of a 950-hp 4160-v motor was mounted vertically with a standpipe through its center. Standpipe was equipped with nozzles to spray the winding with water. During a 275-hour dousing, insulation resistance of the winding flattened out at 1 megohm after a downward dip. When water was shut off, readings shot up to 10 megohms in 1 hour with the motor at room temperature.

Similar tests on other insulation systems show results much the same as those given above. Tests like these show we are rapidly approaching the ideal motor insulation. It will have essentially no change in resistance when moisture is present, will be impervious to all chemicals and will boast high thermal stability.

Vacuum-pressure impregnation, in combination with dipping of the complete stator, is believed by some to be the secret of complete moisture protection. One manufacturer uses this technique for motors slated for indoor or outdoor service where moisture will be present. Of course, the type insulating material used and its method of application are equally important. Motors through 5500 hp have been completely submerged in a dipping bath to saturate the windings with high-dielectric synthetic sealing varnish.

International standards on way

Work is under way to establish new international standards for electrical insulation; from all signs, tangible results are not too far off. During a meeting of IEC (International Electrotechnical Commission) in Philadelphia, Sept 1954, the following definitions for new international insulation classifications were proposed:

Class E will consist of materials or combinations of materials that, by experience or accepted tests, can be shown capable of operating at Class-E temperatures. This temperature is 15 C higher than for Class A.

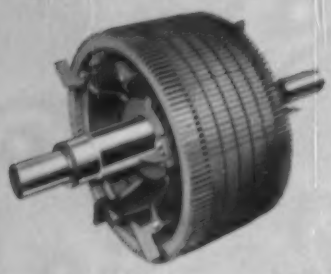
Class-F insulation will be made up of mica, glass fibers, asbestos, etc, along with suitable bonding materials. They may also be used in combination with other materials when experience or accepted tests show the final insulation is capable of operating at 25 C higher than Class-B materials.

IEC is made up of representatives of foreign and American industry. In this country, present standardization work is being carried on by the ASA (American Standards Association), ASTM (American Society for Testing Materials), AIEE (American Institute of Electrical Engineers).

NEMA is keeping a close watch on what progress is being made by the IEC group. Their members have a 2-sided interest; as manufacturers of insulating materials and as potential users in electrical manufacturing.

TYPICAL ROTOR, STATOR CONSTRUCTION FOR LARGE SQUIRREL-CAGE MOTOR

ROTOR is basically made of compressed punchings keyed to a supporting spider. Latter is pressed on shaft. Partially closed cage slots hold bars snug and reduce effective air gap. Cage bars brazed to short-circuiting end rings.



STATOR construction centers about an assembly of sheet steel punchings. Heavy end rings and through-bolts align punchings, clamp complete assembly together under high pressure. The form-wound stator coils are laid into open slots.

MODERN ROTOR CONSTRUCTION favors cast-aluminum cage bars in smaller squirrel-cage rotors. Stators are wound *random* or *form*

Squirrel-cage induction – the basic motor

Motor protection and starting methods are in the spotlight. Trend is toward starting across the line at full voltage, wherever possible

In the remaining pages of this report we will deal with electrical considerations and how they affect motor performance. Motor characteristics will be discussed, as will design features and starting methods. Fitted into this general framework you will find salient facts explaining briefly how particular motors operate.

Motor type is one factor in our 8-point panorama outlined on pp 74-75. All motors, type-wise, may be classified as either *ac* or *dc*. If ac they further subdivide into polyphase and single-phase. Squirrel-cage, wound-rotor and synchronous designs make up the polyphase family. Single-phase ac motors are discussed on p 96, dc motors on p 98. These and next two pages cover squirrel-cage motors.

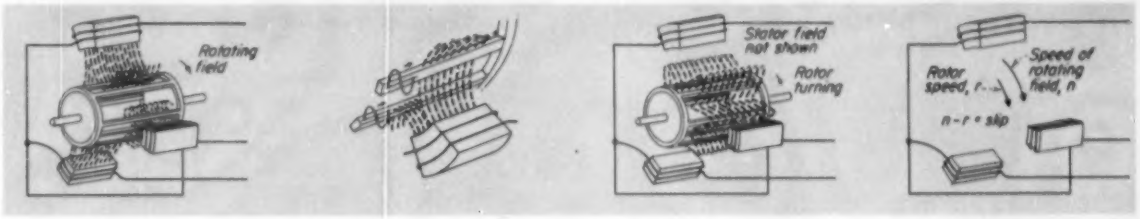
Squirrel-cage motors, like others, have two main parts: *stator,* sometimes called the field, contained in motor's stationary frame; *rotor,* often incorrectly called the armature, mounted on drive shaft and free to turn. Terms stator and rotor are more accurate when describing ac motors since there are some units that have a mechanically revolving field and a stationery armature.

Stator of a 3-phase induction motor has at least three distinct windings. Each winding connects to one leg of the 3-phase supply line. Flow of alternating current sets up a magnetic field, not fixed in space, as is field of dc motor. Instead, field rotates within stator at supply-voltage frequency.

Rotor of squirrel-cage motor consists of laminated iron and the squirrel-cage conductors. These conductors, *photo above,* recess into slots in the laminated core. All conductors of a squirrel-cage rotor are mechanically and electrically connected by end rings. The axial conductors and their end rings make up a unit structure bearing a close resemblance to a squirrel's cage.

Smaller rotors generally have their cage conductors and end rings die cast into the rotor. Another cage fabrication technique, generally reserved for larger machines, involves brazing or welding

How rotating magnetic field gets cage-rotor turning



Stator field

Stator of 3-phase motor is shown here as three coils. After magnetic field is established, peak of field rotates from coil to coil, in sequence. Rotor-cage metal bars and end rings are not connected to outside power

Rotor current

Current is induced in rotor windings as magnetic field of each stator coil builds up and collapses. At standstill this induced current is same frequency as power supply to stator, much like that in a static power transformer

Rotor field

But induced rotor current produces its own magnetic field. This, in turn, through the action of repulsion and attraction, twists the rotor in an attempt to catch up with rotating stator field . . . but never quite makes it

Motor slip

Squirrel-cage rotor runs slower than rotating field since latter must continually overtake and cut rotor windings. This speed difference is called motor *slip* and is necessary for induction of a torque-producting current

Consider these various torques when selecting induction motors

There are several terms that must be understood to make any analysis of motor operation. Perhaps the most fundamental is torque.

Torque is the turning moment at 1-ft radius expressed in lb-ft. It is a measure of the motor's ability to do work. Following are the various torques met in induction-motor calculations.

Locked-rotor torque (also called breakaway or starting torque) is minimum torque a motor will develop at rest, for any angular position of the rotor, with rated voltage and frequency applied.

Full-load torque is the value necessary to produce rated hp at full-load speed. In pounds, at 1-ft radius, it equals the hp times 5250 divided by full-load speed. Example: A 500-hp 1760-rpm motor has the following full-load torque: $5250 \times 500/1760 = 1493$ lb ft.

Accelerating torque is the net difference at any speed between torque required by external load and that developed by motor. It's this torque that accelerates the motor and connected load.

Breakdown torque is maximum torque a motor will develop at rated voltage and frequency, without an abrupt drop in speed. This is sometimes incorrectly called the maximum or pull-out torque.

Starting and breakdown torques vary as the square of the applied voltage. Example: Motor has 125% of full-load torque when started on full voltage; then line voltage is cut to 85% normal. Resulting starting torque: $(85^2/100^2)(125\%) = 90.2\%$ of full-load torque.

Caution: Make sure the starting or accelerating torque available at reduced voltage is large enough to start and bring the connected load up to speed.

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rotor conductors to end rings. Die-casting technique has trimmed time and dollars from cost of manufacturing cage rotors. Experiments with aluminum die casting of rotor cages started in the early 30's. During World War II the copper shortage helped stimulate development of workable cage-casting methods using aluminum.

Rotating field developed in the induction motor is key to unit's torque and speed characteristics. This magnetic field has a definite polarity depending on the momentary direction of current flow. Thus, magnetic field within stator varies both in strength and direction. It's the cutting of rotor conductors by this magnetic field that produces a current in the cage winding, which in turn develops torque.

With rotor stationary, the motor is in effect a transformer having a short-circuited secondary. At standstill, heavy currents at line frequency flow in the cage conductors. Recall from your high-school physics how under such conditions a conductor tends to move at right angles to the magnetic field? So too, a tangential force, or torque, is exerted on the rotor periphery and rotor attempts to turn in same direction as rotating field. One significant factor that limits torque developed is cage-winding resistance.

If enough torque is developed, rotor accelerates to some definite speed at which the turning effort equals retarding effort of load. Rotor never reaches speed of rotating field since relative motion between rotating field and rotor (slip) induces the all-necessary cage current. As load is applied, slip increases. To reverse direction of rotation, interchange any two phase connections to the stator.

Speed of ac induction motor is determined by frequency, *f*, in cycles per second; percentage slip, *s*; number of poles, *n*. Running speed of motor is:

$$S = \frac{100 - s}{100} \times \frac{120\ f}{n} \text{ rpm}$$

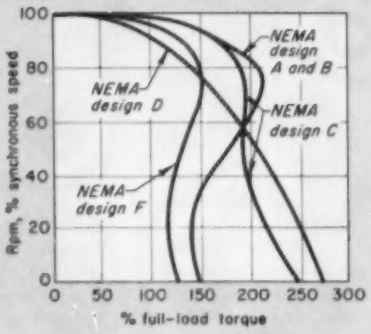
In squirrel-cage motors, slip ranges to 5% of the synchronous speed.

Operating characteristics hinge on these rotor-cage designs

Design A, B
On start and at low speeds, current hugs top of bars; cage resistance and torque are high

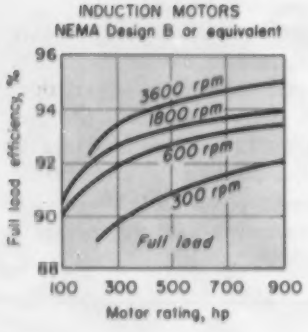
Design C, F
Double-deck slot: At low speeds most current flows in top bars, keeping effective ohms high

Design D
Conductor area is kept small. Effective bar resistance is about same from zero to top speed



BREAKDOWN TORQUE varies in numerical order with the above letters. Breakdown for *B* slightly less than *A*

Despite simple construction, the squirrel cage motor can be built to yield a variety of operating characteristics. Most common designs are NEMA standardized and classified as Designs *A, B, C, D, F*. Basically, torque characteristics and locked-rotor current are the factors that distinguish one design from another; see typical torque curves, *above*. Design-letters' alphabetical order relates to breakdown-torque value.



Motor efficiency and rotor losses

In simple terms, efficiency is measure of motor's ability to convert electrical input into mechanical power.

Recognized induction-motor losses: *stator no-load iron, stator copper, stray load, rotor copper, friction and rotor windage.*

Internal torque developed by squirrel-cage motor is linked to rotor losses. In a wound-rotor motor, losses in resistor are also included.

Modern motor protection includes check on winding and bearing temperatures

Motor protection of large units is generally handled with relays furnished on motor control equipment. Current relays protect against short-circuits; thermal overload relays check on excessive overloads; time-delay undervoltage relays guard against prolonged operation of large units at low voltage.

It's often wise to consider additional protection of motor, say from internal faults and excessive temperatures. If motor is unattended or motor stoppage will not seriously affect production, protective devices can shut down the motor automatically when a dangerous condition crops up. Where production loss is a serious factor, arrange protective devices to give advance warning of an approaching dangerous condition.

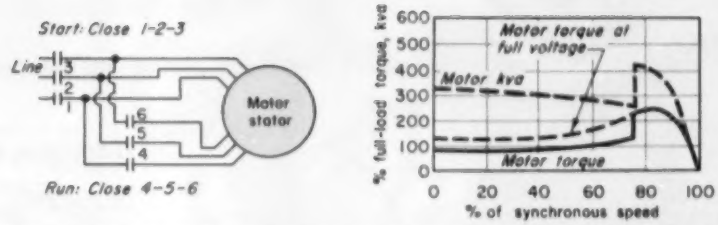
Relay setup detects excessive stator temperatures resulting from heavy overloads, high ambient temperatures and too frequent starts-and-stops. Also, temperature detectors are a guide for maximum safe loading. For motors 1000-hp and larger, temperature detector is generally imbedded in stator winding. On smaller motors, a bimetallic disk-thermostat is mounted on stator winding.

For large motors operating at high voltage, consider protection against lightning surges and fast-opening circuit breakers. One simple method is with capacitors connected from line to ground at machine terminals. They serve to adjust rate of rise of surge voltage.

Differential relays protect motor from extensive damage caused by a fault within motor, also minimize disturbance that such a fault projects to remainder of power-distribution system. NEMA switchgear standards suggest differential protection on motors above 500 hp when rated voltage is above 5000; above 1500 hp when rated voltage is from 2200 to 5000.

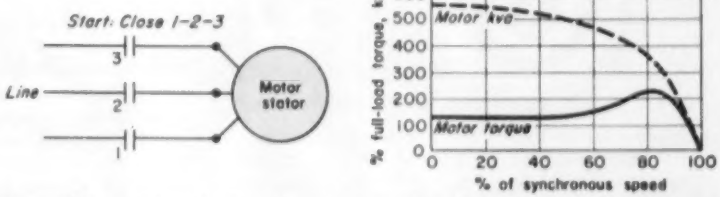
Part-winding full-voltage starting cuts first cost

Principal advantages of reduced-voltage starting methods are incorporated in part-winding full-voltage increment starting. No auto-transformers or resistors are needed. But motor must have a stator with at least two windings that are paralleled when operating.

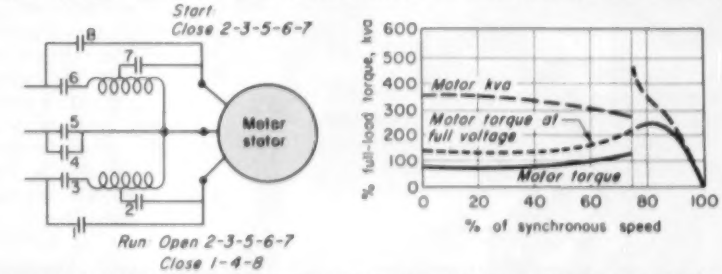


PART-WINDING setup applies full voltage to various stator circuits singly until all are energized. Motor accelerates smoothly since line is not opened during startup

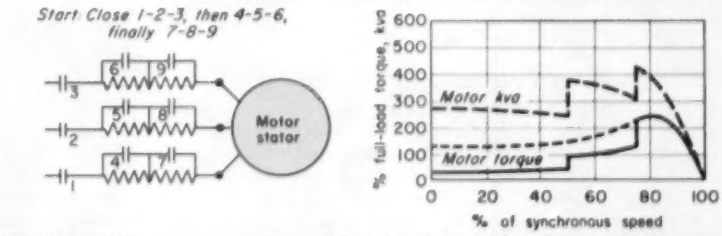
Analyze these starting methods too!



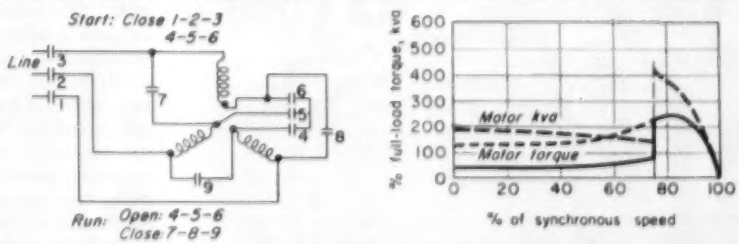
FULL-VOLTAGE is preferred where power source allows kva inrush. Utility may want reduced-voltage starting to limit starting current to fixed percent of full load



AUTOTRANSFORMER reduces voltage on starting. Transferring to full voltage at 75% synchronous speed interrupts current. Generally used on hand-operated compensators



SERIES RESISTANCE (or reactor) provides closed transition from start to run, raising motor kva and torque by steps when uninterrupted starting current is wanted



DELTA-STAR arrangement used widely in Europe, seldom in this country. Motor starts star and runs delta. Results are equal to starting on autotransformer's 75% tap

Space heaters are an accessory that protect windings against moisture during motor shutdown. Typical heaters have a total capacity about 0.1% to 0.5% that of machine rating and generally operate from a low-voltage source. Space heaters maintain machine temperature well above dew point, preventing condensation on windings. In both open and totally enclosed designs, mount heaters inside the motor enclosure.

Motor nameplates contain important information like voltage, hp, amperage, and, in addition to other items, a code letter. This code letter indicates the locked-rotor kva per hp. Letters run from *A* through *V* with the exception of *I*, *O* and *Q*. Multispeed motors are generally marked with code letters designating the locked-rotor kva per hp for the highest speed. For specific values corresponding to various code letters see *MG 1-2.15*, available from NEMA. Code letters are a desirable yardstick of values for starting currents.

Nameplate data are important in motor installation, operation and maintenance. To make full use of them, ask the motor manufacturer for a record card with each unit purchased. The card, containing space for entering nameplate data, is a valuable aid in keeping tabs on the motor.

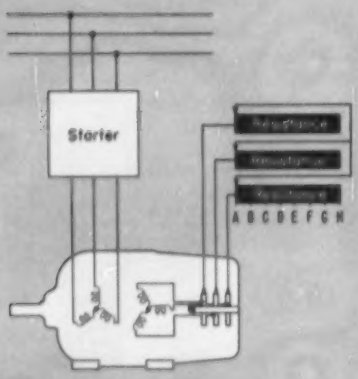
Full-voltage starting would be used on all motors if there were not some serious limitations. First, the motor must be mechanically strong enough, with coils braced to withstand stresses produced by full-voltage starting. Most modern motors comply with this basic requirement. Next, the driven machine must be able to withstand the motor's full starting torque. Finally, the motor's locked-rotor current must not exceed power-company limitations. This is a serious consideration, especially where motor is located some distance from utility primary.

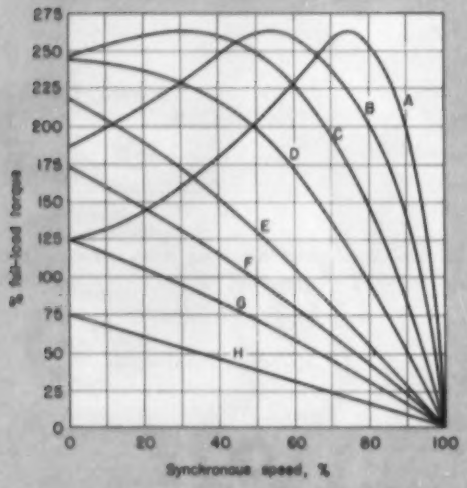
If torque, speed and slip characteristics rule the squirrel-cage motor out, consider the . . .

Wound-rotor

Rotor-winding resistance

Resistance of rotor winding plays an important part in fixing speed-torque characteristics. This resistance is set in the squirrel-cage motor. But in wound-rotor unit, winding leads carry through slip rings to adjustable resistors





TYPICAL SPEED-TORQUE curves, above, illustrate change that occurs as external resistance is added into the rotor circuit. No resistance for curve A, resistance was increased in steps to obtain curves shown at B through H

Basic difference in the construction of squirrel-cage and wound-rotor induction motors lies in the rotor. Both designs use the same stator.

Rotor design provides for connecting rotor windings through slip rings to external control resistors. Reasoning behind this arrangement reverts to the fact that resistance of rotor winding has a marked effect on torque developed at any speed. To get a high starting torque at a low starting current requires a high-resistance rotor winding. To develop low slip at full load, with high operating efficiency and moderate rotor heating, calls for a low-resistance rotor. The wound-rotor slip-ring motor offers a practical means of approximating both these conditions.

Wound-rotor motor has a rotor winding with the same number of poles as the stator. Rotor winding connected to an external resistor has its effective resistance varied by an external controller. Through such a manual controller, or series of magnetic contactors, varying amounts of the external resistance can be shorted out. Speed-torque curves for different resistance steps are illustrated, *left*.

It is possible to build into a squirrel-cage rotor any amount of fixed resistance. And it is possible to match any of the wound rotor's performance curves with a squirrel-cage unit. In such a setup, however, there would be no practical way to change the value of rotor resistance.

The ability to change rotor resistance externally has these advantages: (1) Motor can start with optimum secondary resistance, giving maximum starting torque per ampere. Switch can be made to optimum running resistance for normal full-speed operation. (2) Motor can operate at reduced speed. Example: Fan driven at any selected speed down to 50% of synchronous.

Motor torque and current inrush are controlled by amount of resistance placed in rotor's external circuit. General plan calls for holding starting inrush to about 150% or less, and not exceeding 125% average accelerating current. The operating point for a given value of external resistance is determined when motor torque exactly balances load torque. This point is the intersection of load- and motor-torque curves. For a given resistor value, speed can vary widely if load torque, voltage or other conditions vary.

Controllers for wound-rotor motors come in three general types: (1) manual drum controller with resistors for separate mounting (2) motor-operated secondary control with resistors for separate mounting (3) magnetically operated primary (stator) and secondary (rotor) control. In the latter type, resistors are generally separately mounted above 400 hp.

First two types generally require separate primary con-

Here are 4 reasons why wound-rotor motors pay off

1 Speed control

Induction motors having a wound-rotor readily provide speed variation down to 50% full speed, 40% rated hp. Speed adjustment is handled by secondary resistors, may be manual or automatic. Units well adapted to regulating output of centrifugal pumps

2 Starting torque

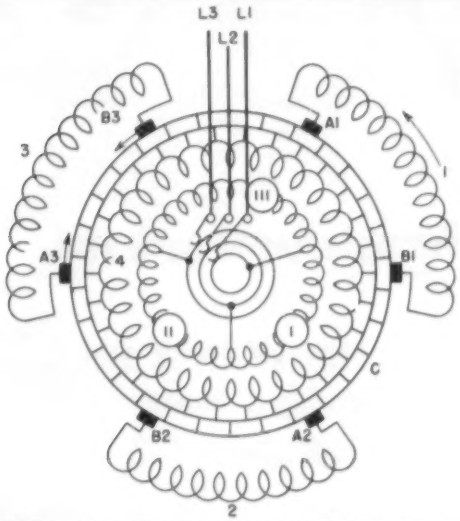
Where high torque and low kva are needed to start heavy loads on power systems with limited capacity, consider the wound-rotor motor. Used for reciprocating compressors, plunger pumps and other applications that may often be started under a heavy load

3 Heat dissipation

With high-inertia loads, like chippers and hammer mills where extremely high slip losses must be dissipated in getting motor up to speed, the wound-rotor motor may be preferred. In a squirrel-cage unit these losses must be dissipated by the rotor of the motor

4 Cushioned peak loads

Wound-rotor induction motor provides high-slip operation allowing you to take advantage of flywheel effect on peak loads. Large chipper and crusher motors are sometimes operated with some rotor resistance cut in on control just to provide high slip for unit



Adjustable-speed ac commutator motor

Rotor winding of this adjustable speed ac commutator motor (labeled 1, 11, 111 in sketch) connects to power supply through slip rings. Rotor also carries a regulating winding similar to that of a dc generator (No. 4 in sketch) Three sets of brushes ride the commutator.

Stator winding, *1, 2* and *3*, connects to brushes. When brushes *A1-B1, A2-B2* and *A3-B3* are adjacent on commutator, stator windings are short-circuited and motor operates as a straight induction unit. At no load the motor revolves at synchronous speed.

However, as each pair of brushes is separated, stator winding is fed a voltage from commutator, which varies with the distance between brushes. At no load, rotating field cuts stator winding, inducing a voltage equal and opposite that impressed by brush shifting. The speed immediately changes from the synchronous value. So motor speed can be altered by changing brush position, under either local or remote control.

trol. But in contrast to squirrel-cage starting, wound-rotor motors always use full-voltage across-the-line starting.

Resistor classification by NEMA for secondary control is a function of motor duty. Classes range from an intermittent-duty resistor, designed for 5-sec operation out of each 80 sec, to one carrying a continous-duty rating. Resistor class also determines the approximate value of current inrush. Resistor steps are usually arranged so average accelerating current is about 125% of full-load value.

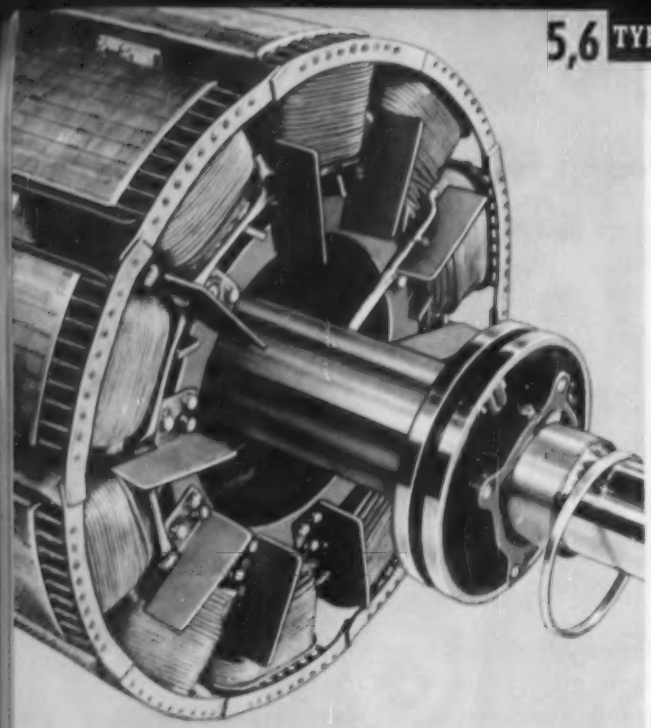
Secondary resistors are grouped in three phases, each phase having the same total resistance and the same number of steps. It is impractical to arrange resistance steps having less than 5% speed variation. For motors rated above 10 hp, resistors in the average wound-rotor control are: (1) Class 134, 135 and 136 for starting duty. (2) Several in Class 150 or 160 grouping, for intermittent duty, as on cranes and hoists. (3) Class 93, 94 and 95 for speed regulation where resistors are rated for continous operation.

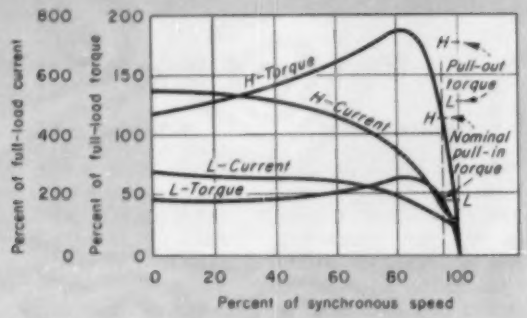
Continous-duty resistors are generally designated for *fan* or *machine* duty: (1) The fan classification is a variable-torque application where the rotor current is about proportional to speed. This type is used with centrifugal pumps, centrifugal compressors and fans. (2) Machine duty is an arbitrary name given to constant-torque applications where the current remains about constant throughout the speed range. Reciprocating pumps, and compressors use this type.

To install the correct resistors in the rotor controller, a control manufacturer must know the load torque requirements. In the everyday installation, the practice is to start a wound-rotor motor with all the external resistance in the circuit. This holds current inrush to a minimum. Resistance sections are then progressively cut out until the desired operating speed is reached.

Application. In the power field, compressors, plunger pumps and production machinery are generally driven by wound-rotor units. They are well suited for applications that must start loaded or that require high starting torque and low starting currents. Also, with high inertia of the driven machine, the wound-rotor motor has a decided advantage over the squirrel-cage.

Wound-rotor motors are often applied where continous operation at reduced speed is required, as with pumps or draft fans. Speed stability is generally unsatisfactory below 50% of synchronous speed.





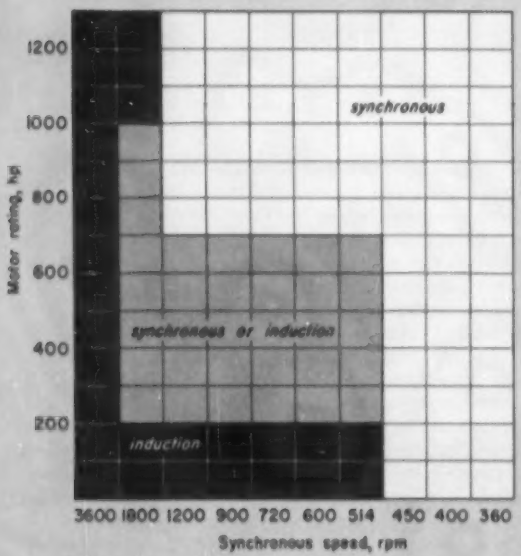
H—Typical high-speed synchronous motor
L—Typical low-speed synchronous motor

TYPICAL TORQUE-SPEED CURVES for synchronous motor. In all, there are 6 important torques, to some extent interdependent, which determine motor's ability to start, accelerate and pull the connected load into step. Motor must also run through load peaks in its design limits

Synchronous or induction?

Here's your practical guide

Synchronous motors can be used for any application a NEMA design-B squirrel-cage motor will handle. But whether a synchronous motor *should* be used is another matter. Cost-wise, here's a handy rule: *Synchronous motors are less expensive than squirrel-cage if rating exceeds 1 hp per rpm.* But this doesn't take into account the higher pf and efficiency of the synchronous motor. These two factors are important in low-speed motors.



Squirrel-cage motors rarely do a good job below 500 rpm because of low pf and efficiency. For especially low-starting kva, where controllable torque, kva or variable speed is wanted, either a wound-rotor or constant-speed motor with slip coupling may be used. Pf and efficiency of today's 3600-rpm squirrel-cage motors are excellent

Synchronous motors

Besides having high efficiency and top torques, synchronous motors will improve over-all plant pf

Look upon modern synchronous motors as double-duty units—efficient means for converting ac electrical energy into mechanical power plus a practical way to correct power factor. *Synchronous motors may be applied to any load that can be successfully driven by a NEMA design-B squirrel-cage motor.* And there are certain type loads to which a synchronous motor is particularly well suited.

Construction is quite different from the induction motor in that the rotor consists of a series of dc-excited poles. Physical makeup of motor may be broken into five parts: (1) *Frame* supports and protects the motor. It is built in horizontal and vertical types and in various protective enclosures for indoor or outdoor service. (2) *Stator* contains magnetic core and stator windings, which connect to ac power supply to provide the rotating magnetic field. (3) *Rotor* includes the spider, field-pole windings, and the amortisseur winding. Field poles, excited from a dc source, interlock magnetically with the rotating stator field when machine is operating. (4) *Exciter* is a dc generator. It furnishes dc magnetizing current through the collector rings to the field windings. Exciter may be driven by the synchronous motor or a separate power source. (5) *Amortisseur* makes the motor self-starting, like a squirrel-cage unit.

Operation of the synchonous motor resembles the squirrel-cage induction machine. When 3-phase ac is applied to stator winding, a rotating magnetic field is set up. As in

FIELD EXCITATION for this synchronous motor is supplied by the dc generator located atop motor. On startup, motor field winding is kept closed through a discharge resistor. After amortisseur winding brings rotor close to operating speed, the dc is applied automatically

do double duty

an induction motor, the manner of winding the stator determines the number of north and south poles. Any one pole will move two complete pole spaces during one ac cycle. For each stator pole, there is a corresponding rotor pole. It is the magnetic attraction between the revolving stator pole and the field pole that causes the rotor to turn.

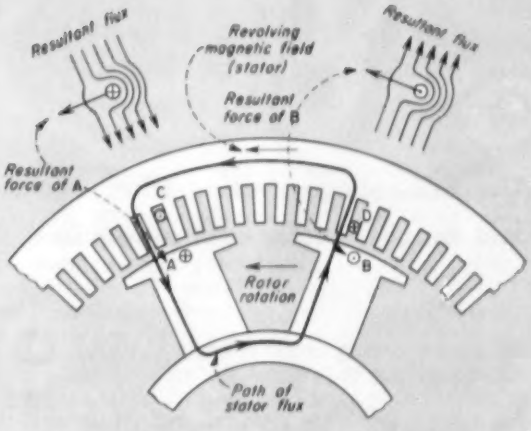
When motor is running under a steady load, there is no relative motion between stator flux and rotor poles. But if load is increased the relative position of both fields changes. Flux between rotor and stator can be likened to linking rubber bands. Visualize the rubber bands stretching with increased load.

If rotor is driven by an external prime mover, rotor poles may get ahead of the stator poles and the motor will operate as a synchronous generator, pumping power back into the ac lines.

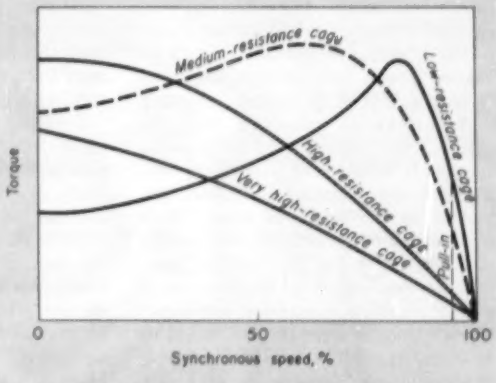
Torque may be represented in any motor-load analysis as either the turning effort developed by the motor or the resistance to turning exerted by the load. Torques are often expressed in lb-ft, although the more general expression is as a percentage of the full-load torque. Synchronous motors have many important torques, which determine ability of the motor to start, accelerate, pull connected load into step and to operate through anticipated peak loads within design limits. These torques are termed *starting, accelerating, pull-up, pull-in, synchronous,* and *pull-out*. Starting or breakaway torque is that developed by the motor at the instant of starting. Accelerating torque is developed between standstill and pull-in. Pull-up torque is the minimum developed between standstill and pull-in. Pull-in torque, a term unique to the synchronous motor, occurs during transition from slip-speed to synchronous. Synchronous torque is that existing during operation. Pull-out torque is the maximum steady-state torque built up by the motor for one minute before it pulls out of step because of overload, caused by the driven unit.

How the amortisseur winding starts the rotor turning

AMORTISSEUR CAGE is a permanently short-circuited winding having its bars uniformly distributed around rotor's periphery. As in the squirrel-cage winding of an induction motor, all bars are joined to end rings. In synchronous generator, cage dampens rotor oscillations

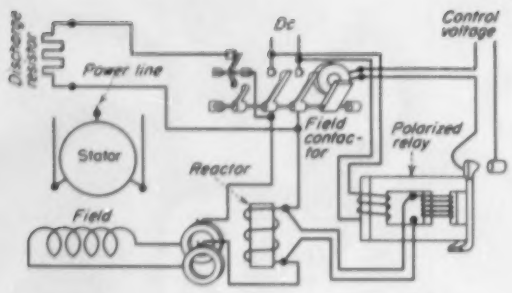


STATOR COIL is *C-D*; cage winding *A-B*. Stator coils produce a magnetomotive force pushing main flux through air gap into pole and spider, back through adjacent pole, air gap, and stator core. Stator magnetic field reacts with field around rotor cage causing counterclockwise rotation



HIGH-RESISTANCE CAGE produces high starting torque, but a low pull-in torque, making it tough for motor to pull load into synchronism. Double-cage rotor, on other hand, gives about 20% higher torque with 10 to 15% lower current inrush at start than with single-cage rotor

Part-winding starting gives smooth increment starts in two



Typical field control, *left,* energizes the dc field to pull rotor into synchronism as it comes up to speed. Once in synchronism, motor runs at constant speed if load torque does not exceed pull-out torque. When started at full voltage, motor will pull 300 to 600% rated current. This presents a voltage-dip problem that is being licked through part-winding technique, *see sketch p 89.* It also prevents voltage disturbances from a circuit opening, as when using autotransformers.

Compressor-drive speed-torque curves, *facing page,* illustrate a 3-step part-winding on a 75-hp 257-rpm 208-v motor driving a refrigeration unit. Flour-mill drive curves, *far right,* are for a 4-step part-winding setup on a 450-hp 225-rpm 2200-v motor serving as the drive for mill lineshaft.

Use full-voltage starting wherever possible to keep initial cost down and simplify motor control required

Synchronous motors are not self-starting; so they are built with a *damper* or *amortisseur* winding. With the field coil shorted through a discharge resistor, the damper winding acts like a squirrel-cage rotor, bringing the rotor practically to synchronous speed. At that point the dc field is applied and the motor pulls into synchronism, providing it has developed sufficient pull-in torque. Once in synchronism, the motor runs at constant speed so long as load torque does not exceed maximum or pull-out torque. If it does, motor drops out of synchronism. Driven unit is often started unloaded.

Amortisseur winding develops most of the starting and accelerating torque. It consists of a partially distributed cage winding with bars imbedded in the field-pole faces. These bars are short circuited at each end by end rings. Varying the number, location and resistance of the bars has a sizable effect on torque and kva input. Often a double cage is used, made up of a row of shallow bars and a row of deep-set bars. These may have separate or common end rings.

Aim in using a double-bar is to get a uniformly high value of starting and accelerating torque. The shallow cage has high resistance, low reactance; deep cage has low resistance, high reactance. At standstill the slip frequency equals line frequency so the high reactance of the deep cage forces most of the induced current to flow through the shallow-cage high-resistance bars resulting in high starting torque.

As rotor comes up to speed, slip frequency decreases and with it the impedance of the deep cage. This permits more of the induced current to flow through the deep-set low-resistance bars, resulting in high torques as rotor approaches pull-in.

Starting methods. Torques required on starting for salient-pole industrial synchronous motors range from 40 to 200% of full-load torque. For a given starting torque, the starting kva in percent of full-load kva increases as the ratio of pull-in to starting torque. Since starting kva of synchronous motors often taxes capacity of power supply, extreme care must be taken in analyzing starting conditions. These include system capacity, torque requirements, starting kva and method.

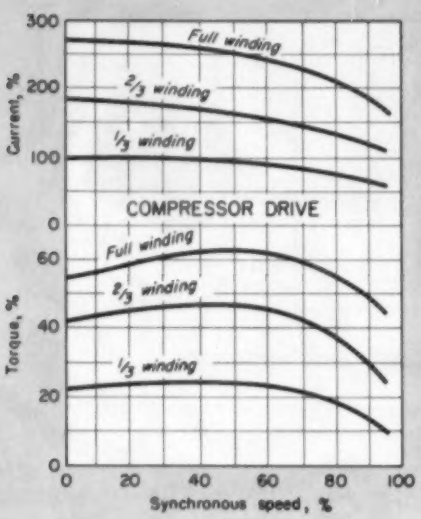
For reasons of lower first cost and ultimate simplicity, use full-voltage starting wherever possible. However, some installations require a reduction in starting kva. So scan the suggested starting methods outlined for squirrel-cage motors on p 89.

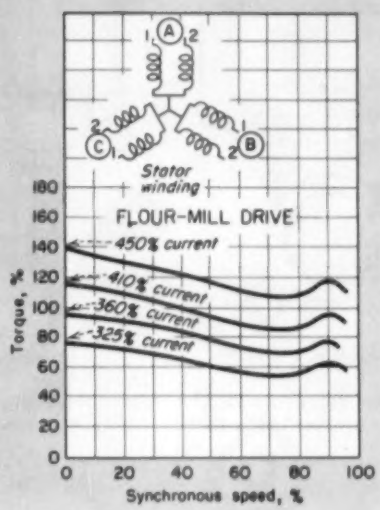
It's fundamental that enough torque must be developed to start and accelerate the load properly. On some high starting-torque applications, the motor need not start on the first step where part-winding, reactor or resistor starting is used. Additional increments are applied until the motor starts and accelerates. Any such method reduces the mechanical shock on driven equipment. And on regulated systems it permits restoration of normal voltage before the next torque and kva step.

Part-winding starting has all the advantages for synchronous motors we outlined for squirrel-cage motors on p 89. Use it where torque requirements or power-supply limitations make two or more starting-current increments desirable. For part-winding starting, the stator must be wound with two or more parallel circuits. These are switched separately and successively on the line in starting the motor.

Application rules that always hold are difficult to establish. We can, how-

or more steps with minimum of auxiliaries





Vertical drives present problems

Pumps often use vertical-type synchronous motors. Electrical characteristics are the same as for a horizontal drive, but mechanical problems are somewhat different. Vertical motor must have a thrust bearing capable of handling entire weight of pump and motor rotating elements. Thrust bearing may be ball, spherical-roller or pivoted-shoe type. Reverse overspeed protection requirements may be higher than standard. Example: A motor driving a pump under high head may be reversed and driven by the pump when the power fails. Protective device disengages motor

ever, outline some general thoughts to serve as a preliminary guide in selection of synchronous motors.

Where very low starting kva, controllable torque or variable speed are required, a synchronous motor and a slip coupling may be used. At 3600 rpm, synchronous motors may be used from 2000 to 5000 hp. Above that range they should be first choice. At 1800 rpm it is questionable whether synchronous motors show any advantage above 1000 hp. In lower ratings they may be used to improve pf.

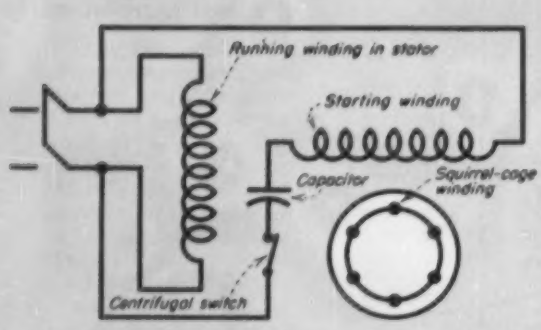
In the range from 500 to 1200 rpm, any motor slated for continuous duty, and rated 700 hp and above, could well be synchronous. From 200 to 700 hp in this speed range, the choice depends on value of pf improvement, energy cost and operating hours. Because of low efficiency and pf, induction motors should rarely be used for operation below 500 rpm. Synchronous motors are built to operate at unity and leading pf and with good efficiencies down to 72 rpm.

For direct connection in ratings above 200 hp and speeds below 500 rpm, the synchronous motor should be first choice for compressors, grinders, mixers and chippers. As indicated in the selection chart, *p 92*, direct-connected motors, 100 hp and above, operating at 500 rpm or less, should usually be synchronous.

Remember that, though leading-pf motors are less efficient than unity-pf types, they do double-duty. Whether they should be used depends on the specific need for pf correction. One exception is motors that require exceptionally high starting, pull-in or pull-out torques. Here unity-pf motors may pose undesirable design angles.

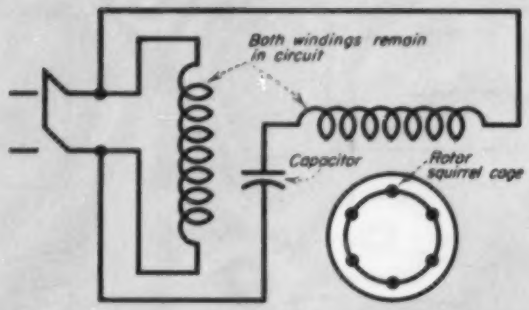
Here's a quick construction comparison between induction and synchronous motors

Motor part	Induction		Synchronous
	Squirrel-cage	Wound-rotor	
Stator winding	Random or form-wound insulated coils placed in slots	Random or form-wound insulated coils placed in slots	Construction similar; for equal rating there are usually less coils
Rotor winding	Cage winding carries both starting and running current	Form-wound coils connect to slip rings on rotor shaft	Cage winding for starting; dc exciting winding carries running current
Slip rings	None	Three rings connect rotor winding to external resistors	Two rings connect field winding to dc source
Air gap	Small	Small	3 to 5 times greater than induction



Capacitor-start

Capacitor holds current in start winding out of phase with running current. Centrifugal switch opens at about 80% speed



Capacitor-run

Capacitor always remain in circuit. Being a form of 2-phase motor, this type is quieter, vibrates less than split-phase

Capacitor-type single-phase induction motor

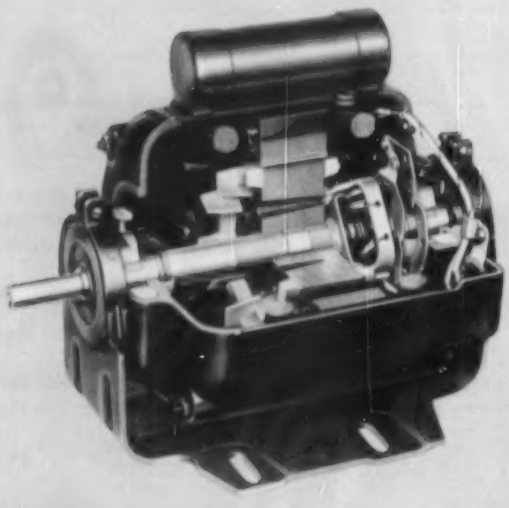
In the early days of alternating current, electrical distribution was generally single-phase and often at 133 cycles. So application of large single-phase motors was more common than today. Modern 3-phase distribution has popularized the polyphase motor for all but low hp applications.

Starting method is a major consideration since single-phase squirrel-cage motors are not self-starting on a single running winding. All single-phase units, other than the universal type, must have an auxiliary means for developing starting torque.

Basic types of single-phase motors include *shaded-pole, universal, split-phase, capacitor, repulsion-start, synchronous.* With the exception of universal, synchronous, and some forms of the repulsion design, they all run as induction motors. Following types found in integral sizes:

Split-phase design is the simplest. It has a squirrel-cage rotor and two stator windings spaced 90 electrical degrees apart; *see sketch.* Auxiliary or starting-winding poles are physically halfway between main winding poles. At start, both windings are in parallel across the line. When rotor reaches about 75% full-load speed, a centrifugal switch opens the auxiliary winding circuit. Design of auxiliary winding is such that current in it is out of phase with current in main winding. This differential is just enough to produce a magnetic field like that in a 2-phase motor. Split-phase motors have low starting torque, high starting current. They are applied to small fans and unit heaters.

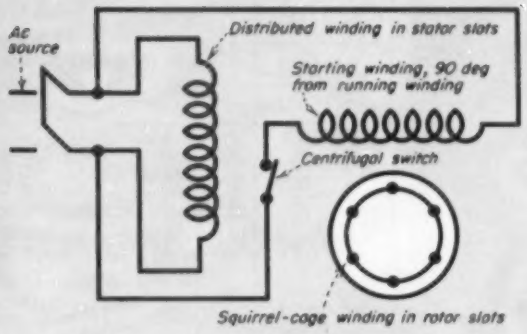
Repulsion-start design was the first commercially successful single-phase motor built in integral size. Rotor winding connects to commutator. Heavy starting torque di-



Repulsion-start or capacitor-start?

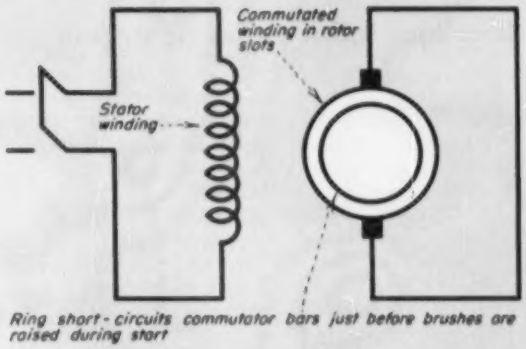
Trend today is for wider use of capacitor motors. Yet many power men prefer repulsion-start designs for certain applications. Comparing the two types, capacitor-start has same type of centrifugal switch used in split-phase motors. So while this mechanism is simpler than in repulsion-start, it nevertheless has moving parts, bearing surfaces and contacts subject to wear and deterioration.

Repulsion-start motor has brushes and a commutator that require periodic attention. This is a big drawback in the minds of many engineers. Yet for practical operating results, both designs are thoroughly reliable and operate satisfactorily.


AC source
Distributed winding in stator slots
Starting winding, 90 deg from running winding
Centrifugal switch
Squirrel-cage winding in rotor slots

Split-phase

Like capacitor motors, this design has two windings in the stator. One is running or main winding, other for starting


Commutated winding in rotor slots
Stator winding
Ring short-circuits commutator bars just before brushes are raised during start

Repulsion-start

In some designs, brushes are lifted automatically after the bars are short circuited. Others let brushes ride on commutator

fits most needs

minishes as motor comes up to speed. If provision is made to short circuit commutator at about 75% of synchronous speed, motor operates as an induction unit. Applications include compressors, pumps, stokers, blowers.

Capacitor-start motors use a modified auxiliary winding and centrifugal switch with a capacitor in series to give good starting characteristics. This design has been available for many years but was not widely manufactured till the coming of the electrolytic dry-type capacitor. Today it is used interchangeably with the repulsion-start type.

Variations of this design include the capacitor-run motor, which has the capacitor permanently connected in series with the auxiliary winding. In the same family is the capacitor-start-and-run motor which has an electrolytic capacitor in series with the auxiliary winding *only during the starting period*. A liquid-filled capacitor is permanently in series with the auxiliary winding.

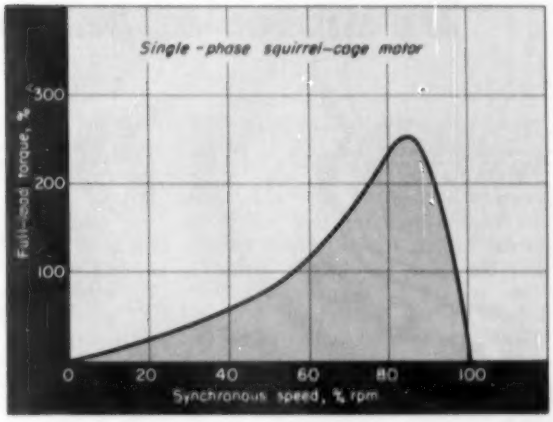
Reversing rotation of many single-phase motors simply requires interchange of leads on either the auxiliary or running winding. Repulsion-type motors can be reversed by reconnecting the field winding or brushes.

Performance of single-phase designs varies with the particular motor. Permanent capacitor motors have very low starting and pull-in torques; about 50% of full-load torque. They also have a rather low full-load speed. Load's torque needs must be checked carefully before applying this design since torque required to accelerate load may exceed that developed by motor.

Split-phase designs boast starting and pull-in torques from 150 to 230% of the full-load value. Capacitor-start and capacitor-start-and-run motors have starting torques from 350 to 450% of the full-load torque. Pull-up value is about 200% of the full-load torque.

Repulsion-start motors have starting torques in the 350 to 550% range. Their pull-up torque is slightly less than for capacitor start motors, but their starting-currents are less than in any other single-phase design.

Here's why all above motors need auxiliary starting means

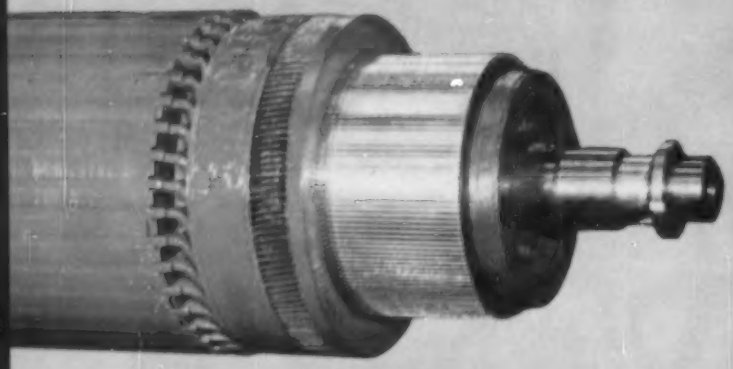


Starting method to get rotor turning and up to speed is a basic consideration for all single-phase motors. Above curve shows the speed-torque relationship when only the running winding is in the circuit and some outside means is used to bring rotor up to speed.

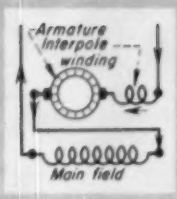
Actual curve for a two-winding motor shows a starting torque over 100% full-load value because of auxiliary winding. Note from curve that once motor reaches 75 to 80% full-load speed, the main winding develops sufficient torque to operate motor alone.

If auxiliary winding remains in circuit after motor is up to speed (switch sticks closed) resultant torque of both windings is less than that of running winding alone. In addition, the auxiliary winding would in time burn out.

Dependability of modern rectifiers stimulates wider use of dc motors

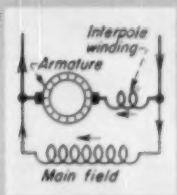


HIGHER FIRST COST plus the additional maintenance required are factors you should consider in any dc motor application



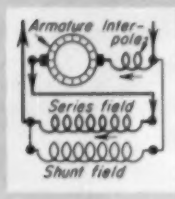
Series

Where high starting torque is needed, and speed can be regulated. For traction, bridges, hoists, gates, car dumpers



Shunt

Where constant or adjustable speed is needed, and starting conditions are moderate. Fans, centrifugal pumps, elevators



Compound

For high starting torque combined with fairly constant speed. Used on geared elevators, punch-presses, plunger pumps

Dc motor applications continue to climb

The dc motor is far from a dead duck. Pendulum started swinging in its favor during the late 30s, after many years of drifting the other way. There are two reasons for this rebirth of interest. *First*, a growing need for adjustable speed throughout industry. This should increase as we move closer to the automatic factory. *Second*, the development of highly efficient, low-maintenance rectifiers.

Today's industrial plants seldom consider generating dc for their power needs. Mg sets or rectifying equipment is now being located alongside production machines. Short dc leads are run directly to the motor.

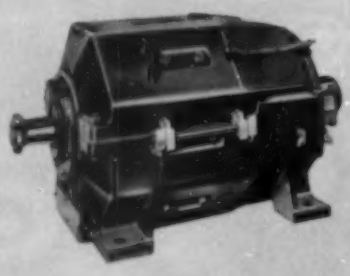
Where to use. The dc motor is used where an ac motor won't do a satisfactory job. Remember, dc motors are a premium-priced product, especially in the larger sizes. But they offer topnotch adjustable speed, effective and simple control of torque, acceleration and deceleration. Even with the limitations of a commutator they can and do handle tough duty cycles. Need for critical speed adjustment and continuous processes often finds dc motors operating in tandem with speeds of each unit changing proportionally over a wide range.

A few words about dc motor size: Rule of thumb says that maximum economical size is not exceeded so long as product of horsepower and speed is less than 1.5 million. Voltage-wise, think in terms of 250 volts for units up to 500 hp, 600 v for 600 to 1000 hp, 700 or 900 v above 1000 hp.

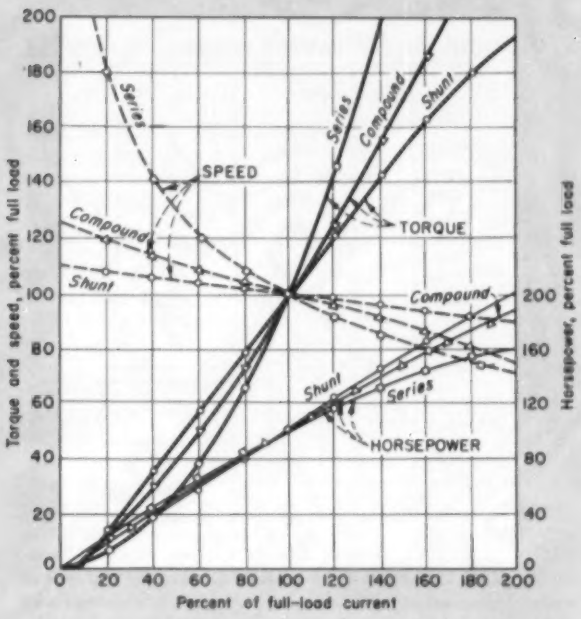
Classes. Dc motors are divided into 3 classes: *series*, *shunt* and *compound*. In all three the armature is practically the same. Main difference between motors is in field coils and hookup.

Series design is simplest of the three. Since armature and field are in series, latter is wound with conductors large enough to carry armature current without big losses. High ratio of no-load to full-load speed leads to using the series motor in hoist and traction work where the speed must vary inversely with load. Example: Low-speed lift operation is wanted on a hoist. But when moving the empty hook, a high speed is desirable. Inherent speed regulation of the dc motor gives this with minimum of control. But this same speed characteristic makes it necessary to positively connect motor to load through couplings or gears. *A series motor without load will race at high speed. In larger sizes,*

Mill motor for heavy-duty outdoor service



Standards for this mill motor were developed by a NEMA-AISE (Association of Iron and Steel Engineers) group. Suited for outdoor use without added protection, it is available from 7.5 to 200 hp, equipped with roller bearings. An overflow sump reduces the possibility of overgreasing. Horizontal split allows frame to be swung back for armature removal.



New industrial dc motor bows in

For some time manufacturers have been taking a hard look at their dc motors with an eye to possible areas for design improvements. Need for change arose from the growing emphasis on adjustable speed throughout industry. Right now manufacturers are coming out with new designs and NEMA standards will undoubtedly follow.

New motor in the 1- to 200-hp range has a dripproof enclosure and Class B insulation. It will be rated for a 60-C rise. And in line with rerating of ac designs, *p 77*, there will be more hp in a given frame.

Voltage rating is also in for revision. Old dc units generally carried a 115- or 230-v tag. These new fellows will be labeled for 120- or 240-v, closer to the generator voltage ratings: more practical to change motor than generator.

as plants call for more adjustable speed

the series motor will be destroyed on runaway by centrifugal force.

To prevent dangerous changes in field strength, series motors are sometimes modified to include a small shunt winding strong enough to prevent motor reaching excessive speeds without changing characteristics.

Shunt motors have their armature and fields in parallel, giving essentially constant field strength and motor speed. This design is used both for constant speed (little application today) and adjustable speed jobs. In constant-speed, variation between no load and full load is 5 to 12%.

Speed of a shunt motor is adjusted with a rheostat in field circuit. This adjustment may be as much as 2 to 1 on small units at moderate speeds, but decreases with larger ratings and higher speeds. A final point: Torque varies directly as armature current.

Compound-wound motor is a combination of series and shunt. For drives needing fairly high starting torque and reasonably constant running speed, the compound design fills the bill. Shunt field, usually the predominating one, is paralleled with armature. Series field is in series with armature. By varying series-field strength, speed regulation can be increased to that of a series motor.

Because of series winding, compound motor speed is not as constant with varying loads as the shunt motor. Normal shunt design varies less than 10% from no-load to full load. In contrast, compound varies about 25%.

Commutating or interpoles are used on most dc motors. They are small windings between the main poles. Their job is to hold the neutral on the armature so fixed-position brushes won't spark. Coils of these poles connect in series with armature.

Commutating poles do not completely neutralize effects of armature reaction, so compensating windings are used for severe applications. These are low-resistance windings in series with interpoles, and inserted in a slotted section of the main poles.

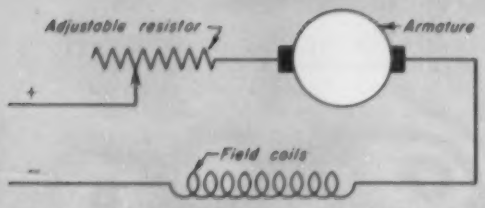
Power supply for dc motors is now generally made up of a number of dc conversion points close to load centers. Local rectifiers with short dc secondaries have replaced central conversion. Mg sets and rectifying equipment follow the packaged theme. In large applications, the packages are full-fledged unit substations with ac circuit-breaker equipment, stepdown transformer, dc conversion unit, dc breakers.

How voltage variations affect dc motors

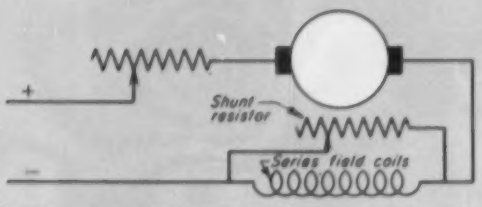
Voltage change from normal	Full-load speed, %	Full-load amp, %	Start torque, % run torque	Max overload cap., %	Temp rise, full load
SHUNT					
10% low	−5	+11½	−16	−16	1
10% high	+5	−8½	+15	+15	2
20% high	+10	−17	+30	+30	2
COMPOUND					
10% low	−6	+11½	−16	−16	3
10% high	+6	−8½	+15	+15	2
20% high	+12	−17	+30	+30	2

1: Main field, commutator and armature higher 2: Main field higher; commutator, armature lower
3: Main field lower; commutator, armature higher

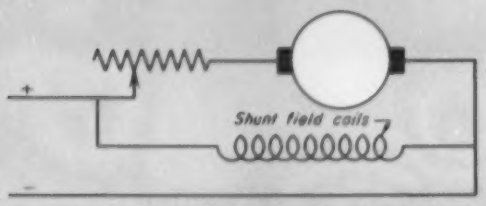
Six ways to control motor speed



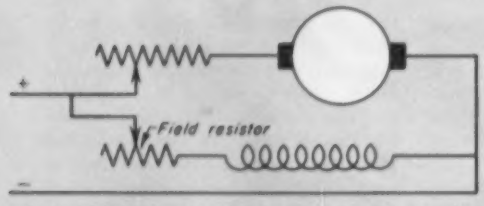
ADJUSTABLE RESISTOR for series motor varies armature, field current. Speed holds constant only under steady load



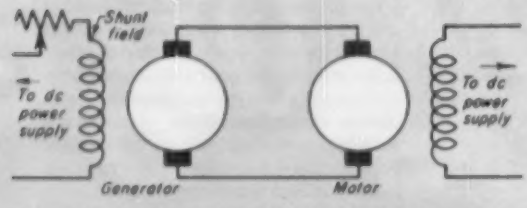
SHUNTING RESISTOR placed across the field winding increases speed of series motor beyond full-load value



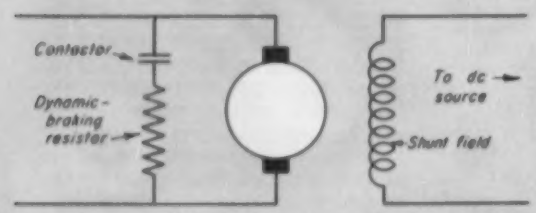
SHUNT-MOTOR speed can be cut below normal full-load point by armature resistance, similar to the series motor



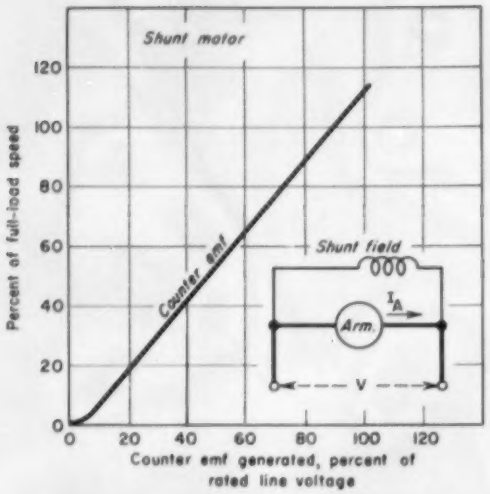
FIELD CONTROL of speed is most economical and satisfactory. Rheostat is small since current is about 5% total



VARIABLE VOLTAGE CONTROL using individual dc generator is efficient way to get speed from zero to maximum



DYNAMIC BRAKING setup has a resistor across the armature to slow motor. Field coils are kept energized



SPEED CHARACTERISTICS of dc motor lean heavily on counter voltage generated. This voltage opposes the line voltage and is almost directly proportional to speed. Line voltage equals the counter voltage plus armature voltage drop. For shunt motors, armature drop is about 10% of the main line voltage

Starting methods show little change. But brush studies continue in quest of still better commutation

In their most fundamental form, starters for dc motors consist of a resistor inserted in series with the armature to limit starting current. As machine speeds up, motor counter voltage increases, allowing resistance to be cut out. Counter voltage opposes the applied voltage and limits current flowing through the armature.

Generated voltage is a function of speed and is nonexistent at standstill. So the only factor limiting current flow through the armature at standstill is the small resistance of winding. If a dc motor were placed across the line, as an ac unit is, the high current would overload the brushes. This leads to heavy commutator sparking, followed by damaging flashover. Motor controllers generally limit armature current on starting to 200% full-load value.

Shunt fields of compound and shunt motors are connected directly across the line on start; armature current is limited by a resistor. A motor requiring speed control by field weakening generally has a separate contact on the controller which shorts out field rheostat for maximum starting torque.

Keep in mind that a dc motor does not have a breakdown torque like a squirrel-cage motor. As motor slows down, torque increases and may damage driven machine if adequate controls are not provided. For quick stopping, use dynamic braking. This requires a resistor across armature terminals, allowing motor to operate as a generator.

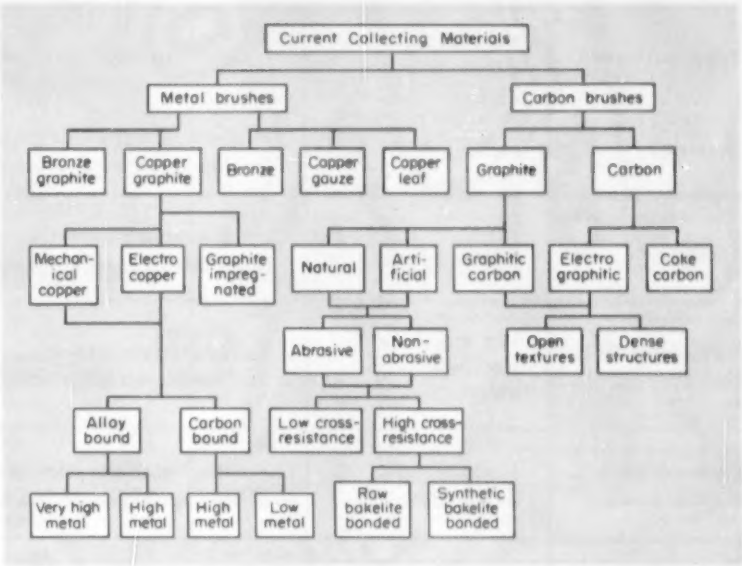
Commutator is the one obvious physical difference

Efficient commutation leans heavily on brush selection and correct setting

Industry is now demanding more of the dc motor than ever before. Engineers are designing for faster changes in speed, current and voltage in the battle to increase production. Example: Reversal time for comparable steel-mill equipment has been reduced to half that of 10 years ago.

Faster rates-of-change in load requirements directly affect commutation. It becomes necessary to adjust dc machines for transient as well as steady-state loads. For complete data on adjusting commutation from brush potential measurements, see POWER, *May 1954, p 82.*

Brush selection in many cases is still subject to on-the-job results before most suitable type is found. Chart, *right,* lists the many types available. See text below for selection information. Check data available from brush manufacturers for further info; also check records of similar machines.



between the dc and ac motor (One exception: ac adjustable speed commutator motor, p91). Made up of a series of copper segments that connect to the armature winding, the commutator is in effect a rotating rectifier. Its main job in life is to permit picking off the unidirectional loops of ac currents generated in the armature.

Over the years, both the commutator and brushes have been the subject of intense study aimed in one direction: how to reduce maintenance and lengthen brush life. Actually, proper brush selection is almost as important as proper selection of the motor. Yet there is no pat formula for selecting the grade best suited for a machine. Even at this late date there is not enough know-how on tap concerning properties of brush materials and machines to make exact predictions as to what will occur in practice. Ultimate test of brush suitability must be made in machine itself. Even a high-quality brush may perform well in one machine and fail in another.

All brushes are made from four general classes of materials, *chart above.* These are carbon, electrographite, graphite and copper graphite.

Carbon brushes are less costly and generally restricted to machines of lower current density and speeds than are found in modern equipment. But since many machines are in service today that are comfortably within this range, the material still enjoys wide industrial use. Carbon grades give excellent results where (1) cleaning action is needed at low peripheral speeds (2) mica is flush and it is impractical to undercut (3) strong oxidizing fumes are present and (4) brush-cost economy is a major factor.

Electrographite has the same base as carbon but is processed at high temperatures in an electric graphitizing furnace. Treatment produces significant changes in material's characteristics, increasing its electrical and thermal conductivity while rendering it softer yet very tough. This change, as applied to brushes, develops a material low in friction, nonabrasive, resilient (ability to ride the commutator without bouncing), cool running and capable of carrying more current than carbon grades. Material loses its abrasiveness in the graphitizing process and so electrographite brushes have little or no cleaning action.

Graphite brushes are readily distinguished from black carbon grades by their silvery appearance and soft flaky structure. High quality graphite for brushes is a mined product, in contrast to carbons manufactured from base materials. In manufacturing graphite brushes, it is not necessary to use high temperatures. As a result it is easy to add any wanted amount of cleaning materials. One valuable property of this class of brush is that its abrasive action may be altered without change in grade.

Here's a fine point: Most graphite grades are made so the resistance between heel and toe is considerably greater than lengthwise resistance. This adds to brush commutating ability since it tends to suppress circulating currents in brush face without increasing contact drop.

Copper-graphite brushes are a mixture of powdered copper and graphite, pressed together and baked at relatively low temperatures. Copper-graphite grades are primarily designed for slip rings or commutators having high currents at low voltages. Their low contact drop and high current capacity recommend them for low-voltage generators designed for electrolytic processes. Abrasive actions inherent in metal brushes are dependent on the proportions of copper; the more copper, the greater the abrasive action.

High copper content increases current capacity and contact drop. In selecting copper-graphite brushes, contact drop and commutator film are always factors because with heavy currents, heat loss at brush contacts may be high. Commutator film should be as thin as consistent with satisfactory operation; see POWER, *February 1955, p 130.*

Use this guide when selecting enclosures for large motors

Type enclosure	Ventilating accessories	On-the-job considerations	Relative cost
Dripproof	None	Minimum recommended protection except for slow-speed or compressor motors	$1.00
Splashproof	None	Install in moist locations, especially where subject to water splashing	$1.15—50-C rise $1.30—40-C rise
Pipe-ventilated (self-powered)	Inlet or discharge duct; or both	Sum of pressure drops in ducts and filters must not exceed motor rating limits	$1.25—50-C rise $1.40—40-C rise
Pipe-ventilated (outside blower)	Motor-driven blower; ducts	Provides motor with clean or cool air. May be used in some hazardous areas	$1.08
Self-ventilated with air or inert gas	Inert gas; seals; cooler; protective devices	Install inert gas type in explosive areas where there is no source of safe air	$1.80
Weather-protected	Filters optional	For all outdoor applications. Modern finishes make it well suited for corrosive areas	$1.25—50-C rise $1.40—40-C rise

Motor selection: study load torques and

There are two important factors in getting any motor-driven load started: (1) the speed-torque characteristic of motor and load (2) moment of inertia or WK^2. (W is weight and K the radius of gyration). Value of load's WK^2 affects length of starting period, which in turn determines motor heating; *see* POWER, *July 1950, p 104.*

Motor rating in hp alone is generally inadequate when selecting units for large drives. Horsepower is indicative of a motor's torque at rated speed and during irregular load cycles or pulsating loads. There are many applications today where a given motor may be able to drive a load after the load has been brought up to full speed. But the motor may not be able to develop enough torque to break the machine from rest or accelerate it. So for many machines, torque is the determining factor in motor selection.

Load rating is a prerequisite to motor selection. Start by classifying machines according to starting-load conditions. Here's how this shapes up:

1. *Machines that can be started partly unloaded.* Typical are reciprocating machines, like air and gas compressors, where static torque needs are high and the pull-in torque varies with type of unit.

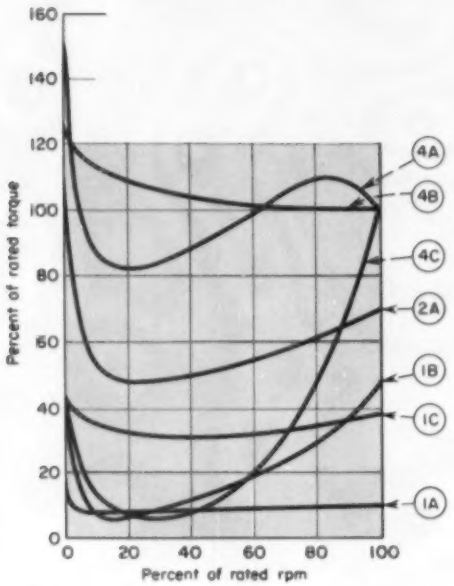
2. *Machines that must be started unloaded.* Here the material being processed completely blocks motion after machine stops. Attempting to start a unit of this type under load would require prohibitive torques. And even if the torque were available it might wreck the machine.

3. *Machines that should be started unloaded.* This pertains to any of the above machines possessing a high moment of inertia. If started without unloading, a high accelerating torque is needed, in addition to the load torque. This would cause overheating of the squirrel-cage rotor of induction motor or cage winding of synchronous motor.

4. *Machines which must be started fully loaded.* Some production machines cannot be started unloaded. In others, any deviation from planned starting increases rather than decreases torque needs under normal operating conditions.

Torque needs of many machines must often be modified to meet the values available in the practical motor. There are two practical ways to cut load torque requirements on starting: (1) if possible, unload the driven machine (2) reduce the machine friction. In the second method, the answer may be proper lubrication. Typical is the adoption of hydrostatic lubrication for major bearings, *see* POWER, *Dec 1951, p 81.* This means introducing oil under pressure beneath the shafts before attempting to start. Sometimes use of rolling-contact bearings will make a sizable reduction in starting-torque needs.

Another approach in certain applications is use of a load cushioning device like the fluid coupling. But if this is



(1A) *M-g set*

(1B) *Centrifugal pump, discharge closed*

(1C) *Reciprocating compressor, bypassed*

(2A) *Gyratory crusher, empty*

(4A) *Ball mill, loaded*

(4B) *Cold rolling mill, loaded*

(4C) *Axial-flow pump, discharge open*

SPEED-TORQUE curves for typical loads. Flywheel effect and the time required for load acceleration are neglected here

ambient conditions

impractical, and the design of the machine prevents unloading, then the required torque must be built into the motor. It then becames the motor builder's problem.

Unloading methods vary with specific machines. For reciprocating compressors, general practice is to close the discharge valve, diverting fluid through a bypass. This reduces the backpressure from the receiving line, thereby minimizing torque required to turn unit over.

When operating speed is reached,and an adequate lube film established over all sliding and rotating parts, reducing torque needs somewhat, the discharge valve is opened and the bypass closed.

Other factors to consider in connection with the load are outlined on pp 74-75. Selection chart, *facing page*, is helpful for large motors. Also, see POWER, *October 1953, pp 112-113.*

Summary of motor characteristics, *right*, brings together many of the performance characteristics we have been discussing throughout this report.

Power source should be carefully scrutinized before selecting any large motor. Determine the limitations imposed on starting kva by the supply utility. If motor is on an unregulated line, or a long distance from a regulated source, remember that voltage drop may prevent motor from coming up to speed: quite important with large motors.

Summary of motor characteristics, applications

Polyphase motors

Speed regulation	Speed control	Starting torque	Breakdown torque	Applications
GENERAL-PURPOSE SQUIRREL-CAGE (Design B)				
Drops about 3% for large to 5% for small sizes	None, except multi-speed types, designed for 2 to 4 fixed speeds	100% for large, 275% for 1-hp 4-pole unit	200% of full load	Constant-speed service where starting torque is not excessive. Fans, blowers, rotary compressors, and centrifugal pumps
HIGH-TORQUE SQUIRREL-CAGE (Design C)				
Drops about 3% for large to 6% for small sizes	None, except multi-speed types, designed for 2 to 4 fixed speeds	250% of full load for high-speed to 200% for low-speed designs	200% of full load	Constant-speed where fairly high starting torque is required infrequently with starting current about 550% of full load. Reciprocating pumps and compressors, crushers, etc.
HIGH-SLIP SQUIRREL-CAGE (Design D)				
Drops about 10 to 15% from no load to full load	None, except multi-speed types, designed for 2 to 4 fixed speeds	225 to 300% of full load, depending on speed with rotor resistance	200%. Will usually not stall until loaded to max. torque, which occurs at standstill	Constant-speed and high starting torque, if starting is not too frequent, and for high-peak loads with or without flywheels. Punch presses, shears, elevators, etc.
LOW-TORQUE SQUIRREL-CAGE (Design F)				
Drops about 3% for large to 5% for small sizes	None, except multi-speed types, designed for 2 to 4 fixed speeds	50% of full load for high-speed to 90% for low-speed designs	135 to 170% of full load	Constant-speed service where starting duty is light. Fans, blowers, centrifugal pumps and similar loads
WOUND-ROTOR				
With rotor rings short-circuited, drops about 3% for large to 5% for small sizes	Speed can be reduced to 50% by rotor resistance. Speed varies inversely as load	Up to 300% depending on external resistance in rotor circuit and how distributed	300% when rotor slip rings are short circuited	Where high starting torque with low starting current or where limited speed control is required. Fans, centrifugal and plunger pumps, compressors, conveyors, hoists, cranes etc.
SYNCHRONOUS				
Constant	None, except special motors designed for 2 fixed speeds	40% for slow- to 160% for medium-speed 80% pf. Specials develop higher	Unity-pf motors 170%. 80%-pf motors 225%. Specials up to 300%	For constant-speed service, direct connection to slow-speed machines and where power-factor correction is required

Dc and single-phase motors

SERIES				
Varies inversely as load. Races on light loads and full voltage	Zero to maximum depending on control and load	High. Varies as square of voltage. Limited by commutation, heating line capacity	High. Limited by commutation, heating and line capacity	Where high starting torque is required and speed can be regulated. Traction, bridges, hoists, gates, car dumpers, car retarders
SHUNT				
Drops 3 to 5% from no load to full load	Any desired range depending on design, type of system	Good. With constant field, varies directly as voltage applied to armature	High. Limited by commutation, heating and line capacity	Where constant or adjustable speed is required and starting conditions are not severe. Fans, blowers, centrifugal pumps, conveyors, wood and metal-working machines, elevators
COMPOUND				
Drops 7 to 20% from no load to full load depending on amount of compounding	Any desired range, depending on design, type of control	Higher than for shunt, depending on amount of compounding	High. Limited by commutation, heating and line capacity	Where high starting torque and fairly constant speed is required. Plunger pumps, punch presses, shears, bending rolls, geared elevators, conveyors, hoists
SPLIT-PHASE				
Drops about 10% from no load to full load	None	75% for large to 175% for small sizes	150% for large to 200% for small sizes	Constant-speed service where starting is easy. Small fans, centrifugal pumps and light-running machines, where polyphase is not available
CAPACITOR				
Drops about 5% for large to 10% for small sizes	None	150 to 350% of full load depending on design and size	150% for large to 200% for small sizes	Constant-speed service for any starting duty and quiet operation, where polyphase current cannot be used
COMMUTATOR-TYPE				
Drops about 5% for large to 10% for small sizes	Repulsion-induction, none. Brush-shifting types, 4 to 1 at full load	250% for large to 350% for small sizes	150% for large to 250% for small sizes	Constant-speed service for any starting duty where speed control is required and polyphase current cannot be used

What are "usual" service conditions for a motor?

NEMA classifies seven service conditions as "usual", under which a general-purpose 40-C rise motor (defined below) will operate satisfactorily. Conditions are: (1) ambient temperature not over 40 C (2) voltage held within ±10% of nameplate rating (3) frequency variation within ±5% (4) combined voltage and frequency swings stay within ±10%, while frequency does not exceed 5% variation (5) motor not more than 3300 ft above sea level (6) atmospheric conditions—dust, moisture, dirt, fumes—do not seriously intefere with motor ventilation (7) all belt, chain and gear drives are solidly mounted.

What is a *general-purpose* motor? It's simply an open motor having a continuous 40-C rating, available in standard sizes and with standard operating characteristics. In contrast, a *special-purpose* motor is one designed for a particular application and has special mechanical or electrical construction. *Definite-purpose* unit is any motor designed, listed and offered in standard ratings with characteristics suitable for use under service conditions that vary from the usual.

The term *service factor* enters the picture at this point since it affects the ultimate loading of certain motors. This factor is defined as a multiplier which is applied to a motor's normal hp rating to indicate maximium permissable loading. Service factors apply only to 40-C rise motors. Service factor ranges from 1.4 for fractionals to 1.15 for integral motors above 2 hp. Motors with a 50- or 55-C allowable rise do not have a service factor.

These codes and standards help in motor selection

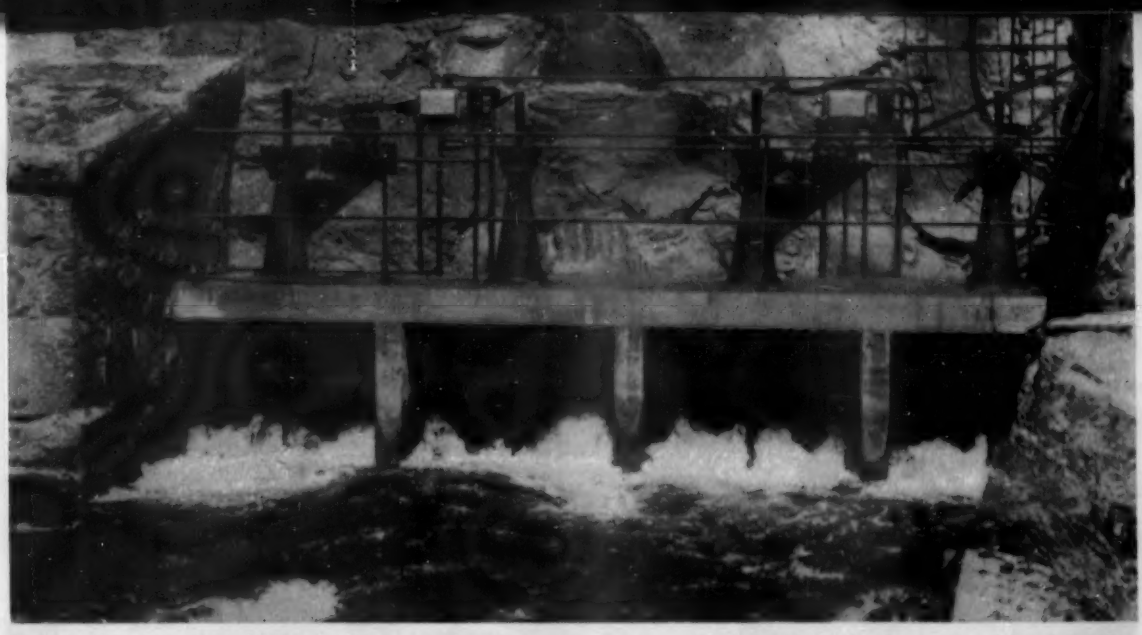
NEMA *Standards* (MG-1-1955) are voluntary standards of the National Electrical Manufacturers Assn. They include, among other things, the frame sizes, torque characteristics and ratings.

AIEE *Standards* concern fundamentals, such as temperature rise, rating methods, insulation classification and test codes. ASA *Standards* are prepared by the American Standards Assn representing manufacturers, distributors and consumers. Their major motor standard is *C-50* (*Rotating Machinery*) which is in substantial agreement with current NEMA *Standards*.

National Electrical Code is an ASA *Standard* sponsored by the National Fire Protection Assn. It is a minimum requirement aimed at safeguarding persons and property from accidents.

Underwriters Laboratories Inc is an independent testing organization. They examine and test materials and systems, keeping an eye peeled for accident hazards. They enter the motor field in labeling explosionproof and dust-explosionproof motors.

POWER wishes to thank motor manufacturers and engineers throughout the country not only for supplying illustrations but for much helpful advice and criticism in the preparation of this report.



FOUR MOTOR-OPERATED GATES, 54x54 in., cast iron, bronze mounted, are installed in sluiceway-discharge ends of hydro-plant dam. Placing gates in the downstream face of the dam allowed installing them without interfering with operation

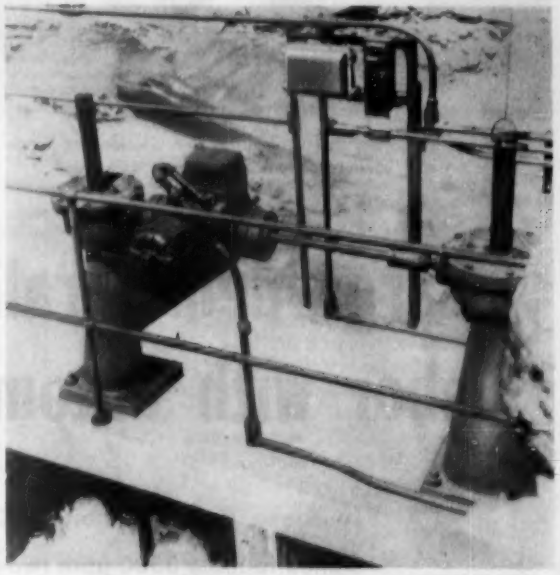
Sluice gates replaced while plant operates

► ENGINEERS of the Rodney Hunt Machine Co had to replace four sluice gates without interrupting water flow to a hydro plant of the Connecticut Power Co. Water to run the plant comes by canal from a dam-formed reservoir on the Farmington River near Unionville, Conn. The former wooden gates closed four sluiceways through the dam in their intakes, held against frames by the weight of water back of the gates.

High maintenance. In winter, it was difficult to keep these gates and frames from freezing as ice had damaged them. Finally, after many years of service, their condition required replacing them. Rodney-Hunt 54x54-in. cast-iron bronze-mounted gates were installed in the discharge ends of the sluiceways. To simplify this job, the old gates were left closed until the new were in place.

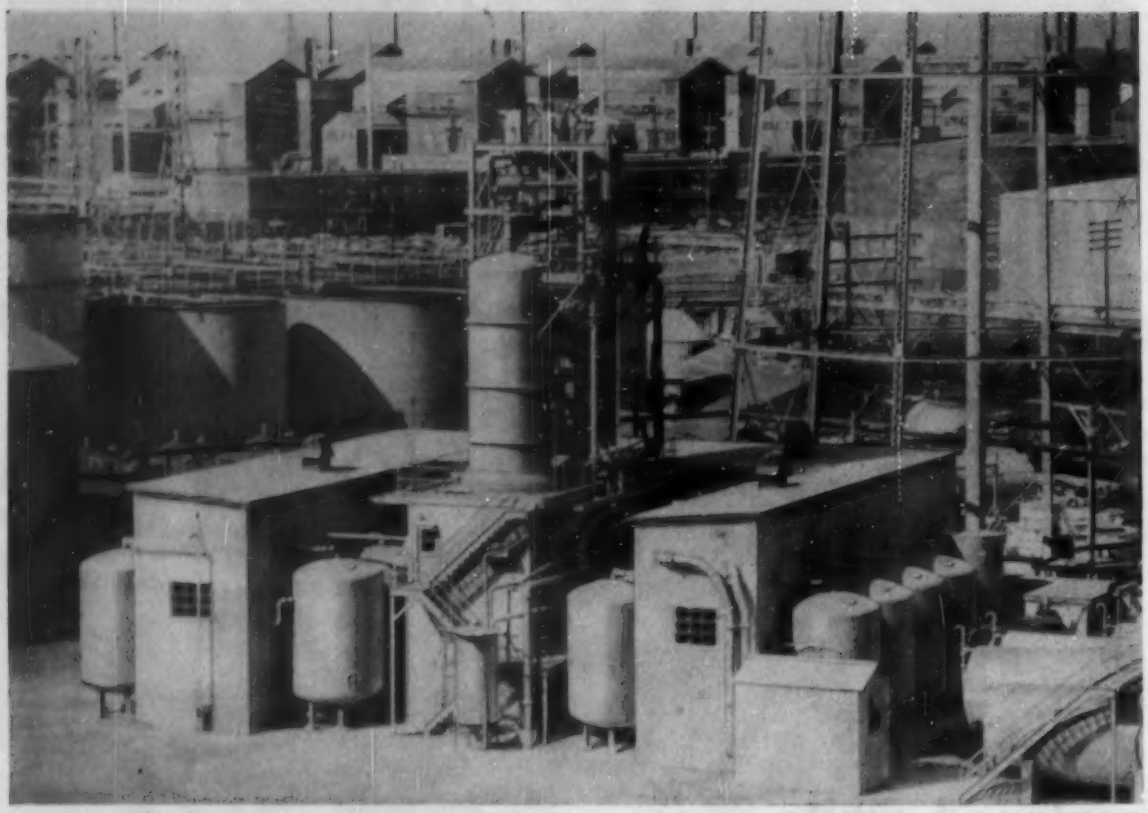
Gate space could be cut in the downstream face of the heavy masonry dam, see photo above, to install the gates without endangering dam stability. A reinforced-concrete structure, built in the sluiceways' discharges and anchored in the dam, supports the gates. A control platform, as part of this construction, provides a foundation for the four gate-hoist pedestals.

A 26-conductor cable ran from the powerhouse to the dam 1½ miles away to control the opening and closing of the old gates and to indicate gate positions. Each Limitorque electric-gate operator for the new gates needs 13 wires for its control and the gate position indicator. If each gate had its own electric operator and signal system, a second 26-conductor cable would have had to be installed.



MOTOR-DRIVEN OPERATOR, coupled to hoists of two sluice gates, can be run from the dam or powerhouse, 1½ miles away

Saving this cable cost presented another problem that was solved by coupling the hoists of each pair of gates to a single operator. This was possible because each electric operator could develop ample power to handle two gates. The gates are now pushbutton operated from the dam or from the powerhouse. Selsyn-transmitted signals show the powerhouse operator the position of the gates at all times.



1 Demineralizing plant at Louisiana Power Station has cation units on left, vacuum deaerator in center and anion units at right. Tanks for regenerant acids and caustic are at extreme right. Controls, pumps and test equipment are housed

Large demineralizing plant saves labor with automatic regeneration

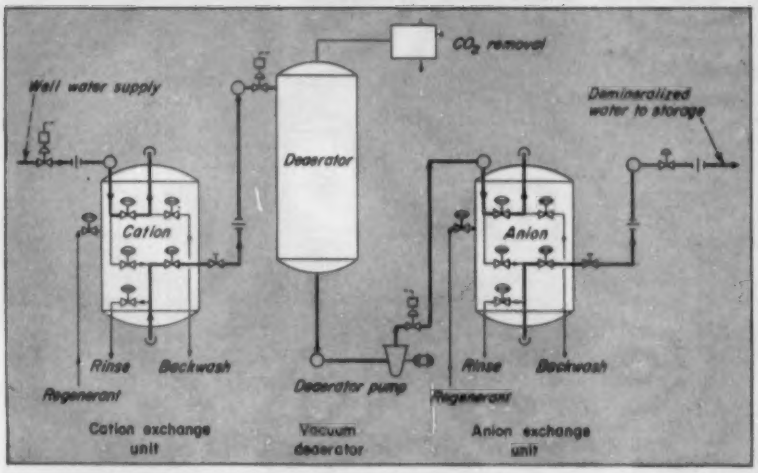
Louisiana Power Station of Gulf States Utilities recently installed reliable 3500-gpm two-bed system to take care of high-pressure 100%-feedwater - makeup byproduct - power plant

By ROBERT H MARKS, *The Permutit Company*

► LOUISIANA POWER STATION of Gulf States Utilities recently added 1,800,000 lb per hr in steam capacity to its plant. The new boilers operate at 1500 psi and 950 F. Steam from these units goes to turbines for byproduct power production. Exhaust from the turbines supplies process steam to neighboring industries at 135 psi. There is no condensate return, so boilers must be supplied with 100% makeup feedwater.

Raw-water supply to the plant comes from either wells or the Mississippi River. Analyses of these waters are shown in the table on the facing page. River water is first clarified.

High makeup rate plus high-pressure boiler operation called for a reliable, flexible feedwater-treatment system capable of producing an effluent extremely low in total dissolved solids and residual



2 Operating flow diagram of the demineralizing plant. Deaerator is evacuated by three-stage steam-jet ejectors—condensate from third stage is sent to waste

OPERATING RESULTS

Name Gulf States Utilities Address Baton Rouge, La.

1. Average Mississippi River Water
2. Maximum Mississippi River Water
3. Average Well Water (Design Conditions)
4. Demineralized Water, Maximum

Analyses of treated waters are typical of results anticipated. Any guarantees with reference to specific constituents are covered separately.

	Substance		Symbol	Parts per million (ppm) as $CaCO_3$			
				1	2	3	4
CATIONS	Calcium		Ca^{++}	52.5	75.0	2.0	-
	Magnesium		Mg^{++}	20.5	24.6	1.2	-
	Sodium and Potassium		Na^{+}	76.3	163.4	170.0	-
	Hydrogen	Acidity	H^{+}	0	0	0	-
	Total Cations			149.3	263.0	173.2	-
ANIONS	Bicarbonate	Alkalinity	HCO_3^{-}	0.0	0.0	132.0	-
	Carbonate	Alkalinity	CO_3^{--}	40.3	40.3	36.8	-
	Hydroxide	Alkalinity	OH^{-}	10.3	10.3	-	-
	Phosphate	Alkalinity	PO_4^{---}	0	0	-	-
	Chloride		Cl^{-}	60.6	157.8	2.1	-
	Sulfate		SO_4^{--}	34.4	48.8	2.1	-
	Nitrate		NO_3^{-}	1.6	2.4	-	-
	Total Anions			147.2	259.6	173.0	-
	Total Hardness			73	99.6	3.2	-
	Alkalinity A (Methyl Orange)			50.6	50.6	168.8	-
	Alkalinity B (Phenolphthalein)			30.5	30.5	18.4	-
	Non-Carbonate Hardness			23.6	49.0	0	-
	Sodium Alkalinity			0	0	165.6	-
				ppm	ppm	ppm	ppm
	Carbon dioxide		CO_2	-	-	-	0.1
	Silica		SiO_2	5	6	25	0.1
	Iron		Fe	-	-	-	-
	Turbidity			-	-	-	-
	Color			-	-	-	-
	Total Solids (Cations + SiO_2)			155.6	271.4	214.8	2.0
	pH			10.5	10.5	9.0	
	Free Oxygen, O_2						0.1

silica. Economic considerations ruled out evaporators. And exhaustive pilot-plant studies showed that either river or well water could be demineralized to meet high-quality needs.

Demineralizing plant, installed to take care of the new boilers, is designed to operate on either well water or clarified river water. But cost for new well facilities was less than cost of duplicate Mississippi River softening and clarification plant. And chemical costs for demineralizing well water is less. So plant now operates on well water.

Basically, the new demineralizing plant consists of eight cation exchangers, two vacuum deaerators, eight anion exchangers and necessary automatic controls, instruments and regenerating equipment (see Fig. 1 and 2). Permutit Q, the styrene-base resin in the cation unit, exchanges hydrogen ions for the calcium, magnesium and sodium ions present in the raw water, thus forming acids corresponding to the anions present.

Carbonic acid formed from the bicarbonate immediately breaks down to form water and carbon dioxide. Vacuum deaerators remove this carbon dioxide along with any dissolved oxygen present.

Permutit S-1, the highly basic anion exchange resin in the anion units, removes the sulfates, chlorides, silica and residual carbon dioxide and replaces them with hydroxyl ions. Hydrogen and hydroxyl unite to form water. The result is an effluent equivalent in quality to distilled water. Last column in the table shows guaranteed effluent analysis.

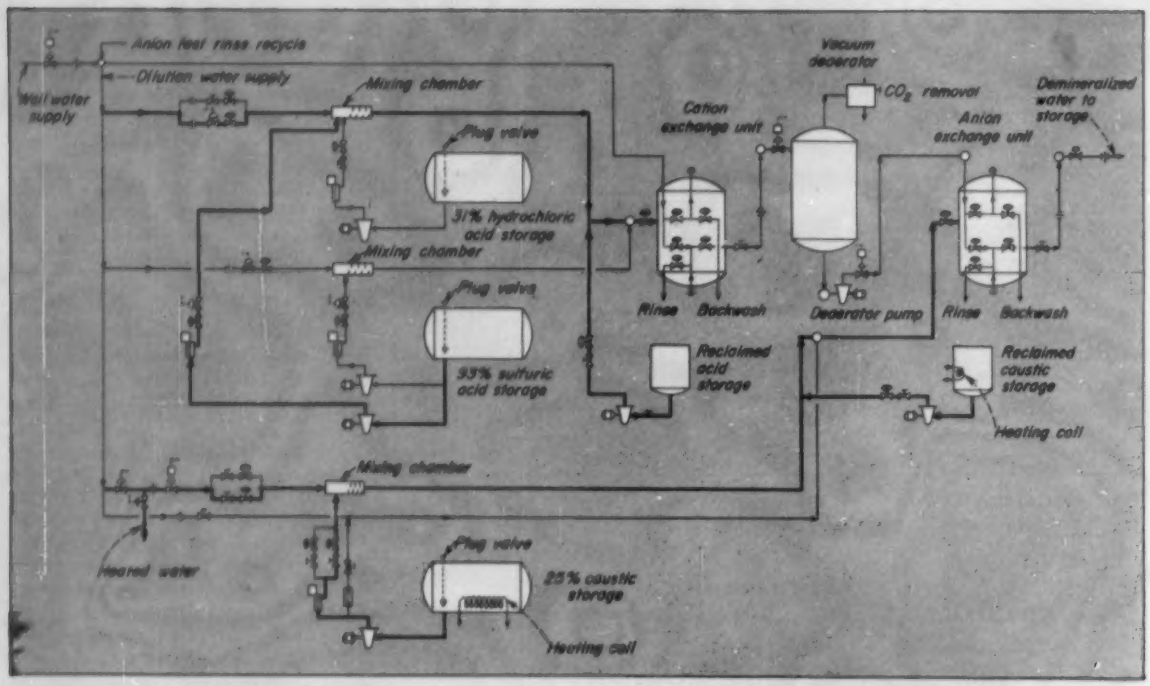
The plant is outdoors with the operating areas enclosed. These include instruments, controls, pumps and manifold valves on the exchanger units. Fig. 1 shows a general view of the plant.

Resin regeneration is the heart of any demineralizing system. The ion-exchange process takes place automatically as long as the resins are in the regenerated state. When the useful exchange capacity is exhausted, the resin must be restored to its original state.

Ion-exchanger regeneration is a lengthy routine usually entailing eight or nine separate operations. Some of these call for preparation and handling of acid and caustic solutions of various strengths. Manual regeneration is, therefore, quite involved and subject to human error. And to get satisfactory results, units must be properly regenerated. To add to this, effects of an improper regeneration are cumulative. The following regeneration, even though properly done, does not erase the ill effects of the previous improper one. This may eventually cause a noticeable drop in exchanger capacity.

Automatic regeneration insures good results at all times. It also reduces the amount of labor needed to run the plant. This allows more time for such important tasks as determining ion-exchanger capacity endpoints, checking plant operating records, performing routine water analyses and, in general, supervising the over-all automatic operation. The demineralizing plant at this Gulf State Utilities station is completely automatic, including preparation of the regenerating solutions.

Regeneration here may be termed



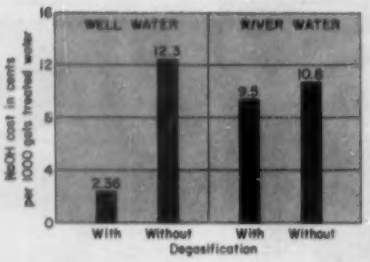
3 Regeneration systems for cation- and anion-exchanger units. There are four main methods for automatic cation-resin regeneration, three methods for automatic anion-resin regeneration. Anion units can also be regenerated by manual operation

Demineralizing plant has highly flexible regeneration setup

pushbutton automatic. Primary control is by metered gallonage set to a silica endpoint on the anion units and to a sodium endpoint on the cation units. The meter contactor actuates an annunciator when preset gallonage is reached. Operator then initiates automatic regeneration by pressing unit's control button. When an annunciator has signalled completion of regeneration, the operator can place the unit back on the line by pressing another control button.

Cation regeneration is usually done with a solution of dilute sulfuric acid to remove accumulated cations of calcium, magnesium, sodium, etc, and replace them with hydrogen ions. This plant, however, was designed to use either sulfuric or hydrochloric acid, or a combination of the two. Complete flexibility was necessary to provide most economical operation when using either well or river water. Chemical reclaiming helps cut regeneration cost.

The well water contains mostly sodium carbonate and bicarbonate. Total hardness, sulfates and chlorides are practically zero. Sulfuric-acid cation-exchanger regeneration with acid reclaiming is particularly adaptable to this type of water. Low hardness means that relatively high acid concentrations can be used without getting calcium-sulfate deposits in the cation-exchanger bed or in the reclaiming apparatus.



CAUSTIC COSTS for anion regeneration with and without the vacuum deaerator

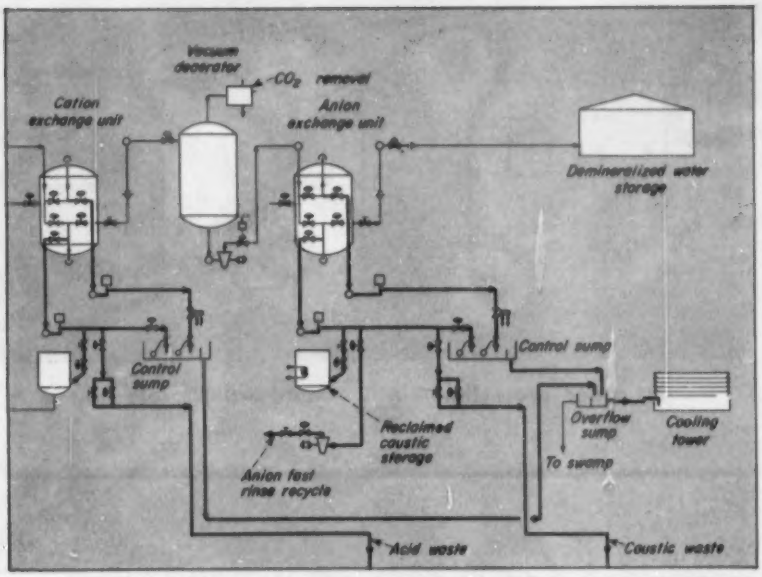
River water presents a different problem. Calcium ions from the river supply, concentrated in the cation-exchanger bed, would precipitate as calcium sulfate when unit is regenerated with strong sulfuric acid. Stepwise regeneration solves this problem. First, dilute acid is used, with gradual increase of the concentration as calcium ions are gradually discharged from the bed. Acid reclaiming with this setup proved impractical.

Hydrochloric acid has a definite advantage for river-water operation, and costs only a little more than the stepwise procedure with sulfuric acid. Calcium chloride formed during regeneration is highly soluble and deposits do not form in the cation units and the reclaiming equipment. So acid reclaiming can be used.

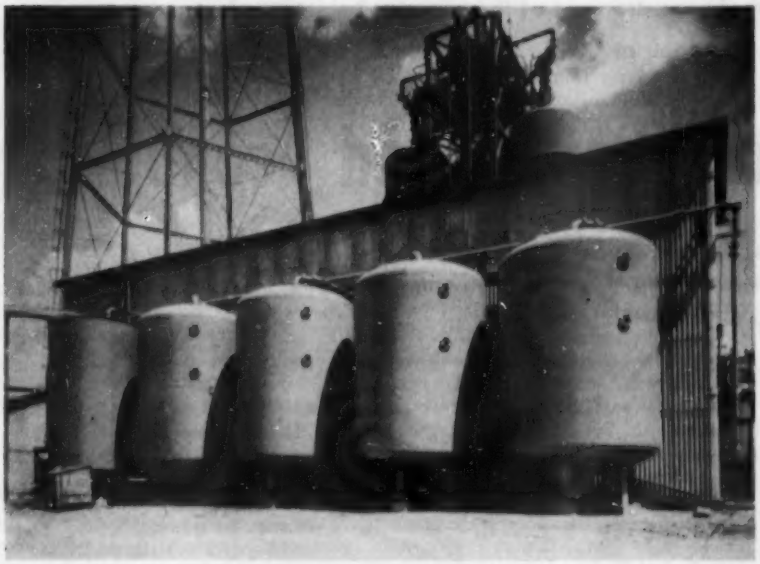
In all, four main regenerating methods are possible—all automatic: (1) sulfuric-acid injection with acid reclaiming (2) hydrochloric-acid injection with acid reclaiming (3) hydrochloric- and sulfuric-acid injection with hydrochloric-acid reclaiming (4) regeneration with all fresh sulfuric acid in three separate strengths without chemical reclaiming (see Fig. 3 and 4 for regeneration setup).

In a typical regenerating cycle, backwashing takes about seven minutes. This water goes to the cooling tower as makeup. Reclaimed acid is then pumped into the cation unit and out the slow rinse line to the acid waste basin. Pump shuts off when low level in reclaimed-acid tank is reached.

The next step is introduction of 5% fresh acid. When dilution water flow



4 Backwash water goes to cooling-tower makeup. Rinse water can go to reclaiming tanks, to waste-disposal facilities or to the cooling-tower basin for makeup



5 Four of the eight cation units with the acid-reclaiming tank to the left. Vacuum deaerators are in background. Cation controls are in shelter next to units

is at a safe value, the strong acid inlet valve opens and the acid pump starts. Acid and water flow into the mixing chamber, through the exchanger and out the slow rinse line. Acid flow is metered, and when a preset total flow is reached, acid and dilution water valves close. Controls reset for injection of higher acid concentration for the next step. When the required volume of acid has been delivered, the acid pump stops and valves close.

Slow rinse flow is controlled by a rate-set valve and measured by a flowmeter in the rinse line. Rinse water goes to the acid-waste basin until acid reclamation starts. This can begin anywhere between the start of the last acid-injection step and the start of the fast-rinse step in the regeneration cycle.

When reclaiming acid, rinse flow is diverted to the acid reclaiming tank until high level is reached. The remaining rinse goes to the cooling tower basin as makeup.

Upon completion of the fast rinse, the unit signals that it is ready to return to service. All timers and counters automatically reset for the next regeneration cycle.

Anion regeneration is done with a warm caustic-soda solution. Caustic removes accumulated anions from the resin and restores it to its original hydroxide form. Two independent systems are provided (see Fig. 3 and 4).

One system is completely automatic and includes three regeneration methods: (1) Reclaimed caustic comes first, followed by fresh 5% caustic solution. Both are automatically heated to about 130 F before injection. (2) Reclaimed caustic is followed with fresh caustic at a higher concentration. (3) All fresh caustic is introduced in two steps of increasing concentration.

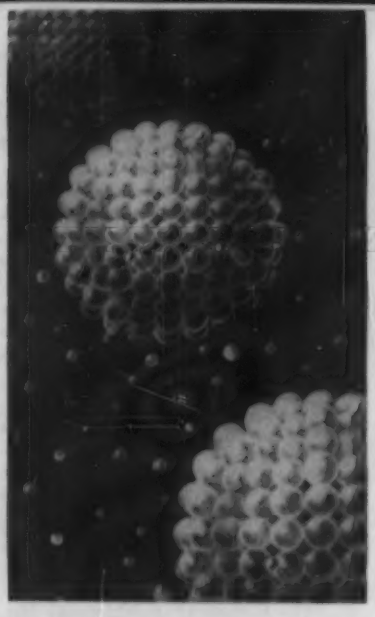
The other system, a standby one, must be operated manually. Caustic would be injected cold in that thermostatic controls would not be functioning when automatic controls are not in service, so steam heat would be off.

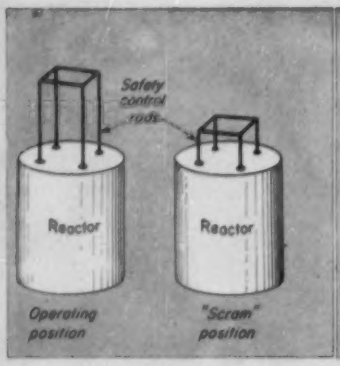
In regeneration cycle, backwash water goes to cooling tower as makeup. Unreclaimed caustic rinse goes to waste-treatment basin. When solids in caustic rinse water drop to same level as in raw water, the rinse water is sent directly to the cation inlet for reuse. This recycling step is continued until anion unit effluent is of the desired high quality. The quantity of rinse water normally sent to waste is reduced as much as 50% by this recycle step.

Vacuum deaeration removes carbon dioxide from the water going to the anion units during normal operation. The deaerator reduces residual free carbon dioxide to about 2 ppm, thus lightening the anion-exchanger load considerably.

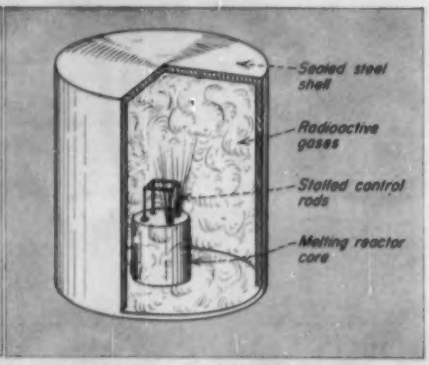
Bar chart on facing page compares caustic costs with and without degasification for both raw-water sources. Chemical cost difference is most striking for the high-bicarbonate well water.

Forced-draft degasification could have been used to remove carbon dioxide. But this would saturate water with oxygen, which must later be removed by deaerators. And well water has zero dissolved oxygen. So more logical approach was to use equipment to remove oxygen or keep it at zero as well as remove carbon dioxide. The vacuum deaerator can reduce oxygen in the river water to about 0.1 ppm.





1st-order protection



2nd-order protection

To choose a power plant we must study its location and costs. With nuclear-fired plants we find new items to consider, while some conventional ones drop out of the picture. To get our feet on the ground, let's look at . . .

Nuclear plant location and economics

By **HENRY C SCHWENK**, *Henry Pratt Company*
and **ROBERT H SHANNON**, *United Engineers and Constructors, Inc*

► THE TWO PHASES covered in this article are probably the most debatable. In five to 15 years when a number of nuclear power plants have run for a time, many of our questions will have been answered and the unknowns uncovered. These two phases are (1) plant location and safety, and (2) economic evaluation.

Plant site, safety. Main factors considered in locating a nuclear plant include:

1. Nearness to load center or existing transmission system.

2. Condenser cooling-water supply: (a) river or lake (b) cooling tower and water for makeup.

3. Containment of any accident that might spread radioactivity to plant surroundings by wind, and surface or underground waterways.

4. *Exclusion area* — reasonable distance between nuclear plant and nearest populated area—tied closely to item 3.

5. Reasonable accessibility for: plant personnel, hauling in equipment, shipping and receiving heavily shielded radioactive materials. May need evaluation of roadway, railroad and dock facilities.

6. Radioactive waste disposal—short-time storage, long-time burial, possible market for some radioactive material.

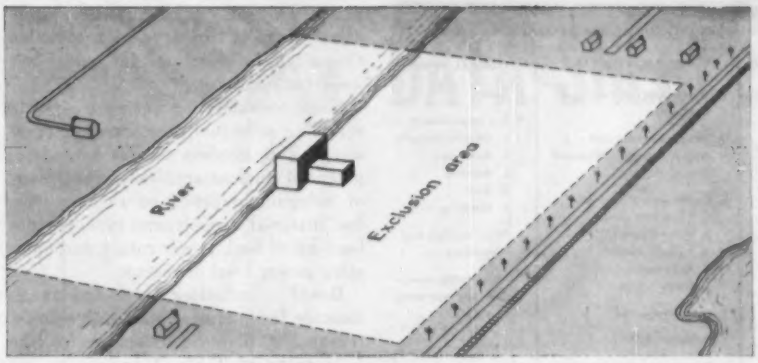
7. Radioactive-gas dispersion to atmosphere.

8. Probability of tornadoes, hurricanes, earthquakes—needs study of past history of region—same as for any other power plant—nuclear plant has associated radioactivity problem.

Failure of (1) reactor control system, or (2) reactor coolant system, or (3) fuel-element handling system endangers the ability to contain radioactivity within a plant system. Any of these failures could: (1) melt fuel alloy in solid-fuel-type reactor (2) rupture or melt reactor and fuel alloy structural materials (3) vaporize liquid coolant (4) vaporize fuel alloy (5) release gaseous fission products. The reactor control system must act fast enough, in a few seconds, or less, to scram (shut down) the reactor in a reactor accident or coolant-system failure. The reactor control must be designed to fail safe. It must be able to scram the reactor even with a loss of power to the control-drive equipment.

Even with all reasonable precautions in control-system design, possibility of an operational failure still exists. A failure could be caused by: (1) distortion of the control elements, supporting equipment, or guide bearings (2) faulty operation of scram mechanism (springs or other devices); so we have to consider "containment" of the radioactive part of the nuclear plant or a reasonable "exclusion area" (isolation) of the plant.

Reactor containment may be a sealed pressure-type vessel holding the reactor and its radioactive auxiliaries. Exclusion area means a reasonable distance, usually measured in miles, between the plant and nearest populated area. Both containment and exclusion area relate



3rd-order protection

Three lines of defense protect a nuclear plant's neighbors from reactor accidents (1) the safety control rods (2) sealed shell container (3) exclusion area surrounding plant building

directly to: (1) reactor type (2) reactor power rating (3) site conditions. They can be used in combination to reduce over-all land requirements.

The Atomic Energy Commission depends on the Advisory Committee on Reactor Safeguards for recommendations as to safety and feasibility of locating all nuclear reactors. Safety of people living near the reactor plant is given primary consideration.

Basic factors in evaluating reactor designs and sites include: (1) reactor type (2) power rating (3) control system (4) coolant systems—especially ability to dissipate reactor-decay heat energy (5) effect of temperature changes in reactor components on reactivity in form of neutron production and absorption rates (6) effect of equipment and system failures on reactor safety (7) effect of system surges on reactor safety.

To receive approval, a reactor design and location must satisfy the following conditions:

1. Reactor design must be inherently safe—for example, a negative temperature coefficient—reactivity decreases as temperature increases.

2. Control system must include enough negative reactivity to overcome all potential excess positive reactivity.

3. Coolant system(s) must be able to remove reactor-decay heat energy following a reactor scram caused by complete loss of primary power source.

4. If reactor fails despite adequate precautions for first three items, complete containment of radioactivity or an adequate exclusion area must prevent endangering people living in and near plant area.

Basically a reactor should be designed to be inherently self-regulating, preferably with a negative temperature coefficient. See Part 9, April 1955, POWER, on reactor control.

Economic studies. About 18 utility and industrial teams are trying to determine technical and economic feasibility of nuclear-fired power plants. Since there are no background cost data on competitive plants built by private industry, estimates must be carefully made with limited data. We will talk about the factors and problems associated with economic studies of nuclear power plants.

Revenue from a nuclear power plant may come from selling: (1) electric energy, and possibly (2) fissionable material. Availability of the latter depends on reactor type: (1) burn-up (2) converter (3) breeder; and whether the fissionable material is Pu-239 or U-233. Plutonium transmutes from U-238, and U-233 from thorium-232.

There is a potential market for radioactive isotopes and for space in and around a reactor as a neutron source for experimental work. We will not include these potential sources of revenue, however, because of the many problems they raise.

Principal considerations in economic studies of nuclear power plants are:

1. Capital investment in plant equipment, construction, land, site improvements and facilities.

2. Plant life—amortization period.

3. Plant load factor—this affects both electric power and fissionable-material production.

4. Fixed charges—including amortization, taxes, bond interest, stock dividends, insurance, etc.

5. Operating and maintenance costs.

6. Income from sale of electric power and fissionable material.

Capital investment. Table 1 gives a representative list of capital investment items for a nuclear power plant. While this list is not complete in detail it points out the equipment that differs from a conventional steam plant fired with coal, oil or gas.

Plant life. Estimated life should be the same for all principal plant equipment and buildings. A 30-year life is representative for amortizing fuel-fired steam plants. A 30-year-life for initial reactor elements and auxiliaries appears over-optimistic. In another ten or 15 years we may have enough experience to justify expecting an operating life of 30 years for reactors. In the meantime, it appears reasonable to assume a useful reactor life of five to ten years. Other parts of the plant will have longer life. Table 2 shows possible ways of handling the problem.

Case A: If government regulating agencies permit a fast writeoff of steam plant this would be an easy way to solve the amortization problem. This, however, increases the economic problem of a reasonable return on the capital investment. For example, fissionable-material production usually takes time to build up to schedule where it is economically feasible to process. Revenue from this source may be low during first two or three years. Also, a short life means higher fixed charges, making it difficult to justify the plant.

Case B: Reduces fixed charges on part of the plant. Then what should be done with rest of plant if reactor lasts only ten years? Some of the likely possibilities are:

1. Consider using up to three successive reactor plants with same steam plant. The second and third reactor plants would be limited to using the

Table 1—Typical investment items for nuclear power plant

REACTOR PLANT—Solid fuel	LIQUID-COOLANT SYSTEM(S)	STEAM-ELECTRIC PLANT	GENERAL PLANT
1. Reactor vessel(s)	1. Piping, valves, insulation	1. Turbine-generator unit and auxiliaries	1. Land
2. Controls and instrumentation	2. Pumps	2. Steam-generator units (boilers common with coolant system)	2. Site improvements a. Fill and dredging b. Roadways c. Railroad d. Dock e. Retaining walls
3. Fuel-element (and blanket-element) fabrication facilities	3. Controls and instrumentation	3. Condenser and auxiliaries a. Circulating pumps b. Hotwell pumps c. Vacuum pumps d. Screenhouse e. Piping, valves	3. Office building and foundations
4. Fuel-element processing facilities	4. Heat exchangers a. Intermediate b. Steam generators (common with steam-electric plant)	4. Boiler feed pumps	4. Initial testing, operation, and operating supplies
5. Radiation shielding	5. Auxiliary systems a. Handling b. Storage c. Purification	5. Feedwater heaters	
6. Electrical systems	6. Inert-gas systems	6. Controls and instrumentation	
7. Fuel-element handling system	7. Building, foundations	7. Piping, valves, insulation a. Steam systems b. Feedwater system c. Auxiliary system	
8. Containment vessel or building		8. Electrical systems a. Switchgear b. Transformers c. Control equipment	
9. Foundations		9. Building, foundations	
10. Health physics facilities			
11. Radioactive waste-disposal facilities a. Solid or liquid b. Gas (stack)			

Table 2—Probable lives for nuclear-plant elements

Solid-fuel-type reactor with liquid-coolant system

Plant element*	Number of years			
	Case A	Case B	Case C	Case D**
Reactor	10	10	10	30
Coolant system	10	10	30	30
Steam-electric	10	30	30	30

*Including auxiliaries and buildings

**For plant designed in 1970

Table 3—Revenue from nuclear power plants

Revenue product	Estimating revenue	
	Method A	Method B
Fissionable material	Assume heat energy equivalent in terms of cents per million Btu	Assume value for fissionable material based on pricing schedule set up by U. S. government
Electric power	Determine cost per kwhr generated, based on: 1. Fixed charges including reasonable dividend on stock 2. Operating and maintenance costs 3. Assumed heat-energy value equivalent for fissionable material produced	Assume value for electric power produced (or heat energy produced by reactor) equivalent to representative cost for area under consideration

steam conditions of the initial plant. This may not be desirable.

2. Consider installing conventional fuel-fired boilers.

3. Consider making the steam plant flexible enough to use increasing steam conditions and capacity that may potentially evolve during next ten or 20 years. This requires especially critical studies to evaluate.

Case C: Provides a more reasonable amortization period for the coolant system(s). Based on present experience with high-pressure water and liquid-metal coolant reactor systems, this period may be realizable. This case involves the same problems on succeeding reactor designs as *B*.

Case D: Puts all plant elements on equal life span. This may be realizable for a plant designed in the year 1970.

Plant-load factor. The reactor of solid-fuel plants will probably have to be shut down during refueling operations. This may take anywhere from a few hours to two days. A reasonable time might be about one-day outage per week for refueling.

Some consideration has been given to refueling solid-fuel reactors while operating. This involves serious hazards of potential nuclear accidents. Frequency of refueling depends on reactor type, fuel material, fuel-element type, percent burn-up of fuel, power rating and operating power level of reactor.

Based on refueling needs and an allowance for operation and maintenance, reasonable plant-load factors for the four cases of Table 2 appear to be:

Case	*Plant-load factor, %*
A	80*
B	80*
C	80*
D	60**

*Highest possible load factor since both fissionable material and electric power depend on reactor operating level. This is important for fast plant write-off.

**The longer the life, the more nearly will nuclear plants duplicate steam-plant experience of serving only system peak loads near the end of their useful life.

Fixed charges on nuclear plants are similar to those for steam plants, which include: (1) interest on bonds (2) dividends on stock (3) income tax (4) depreciation allowance (5) property tax (6) insurance. The last item represents a big unknown at the present time. What will be the potential company liability, and associated policy charge, for a nuclear power plant? Eventually the risk may fall in line with fuel-fired steam-plant experience. Insurance experts are working with industry and government to come up with a realistic answer.

Operating, maintenance costs. Based on present Federal laws vesting ownership of all fissionable materials in the U.S. Government, operating and maintenance costs would be about as follows:

1. Nuclear materials cost—based on solid-fuel-type reactor with initial reactor charge consisting of U-235 and U-238: (a) Rental or lease charge for U-235 and U-238 inventory, including material in reactor, in processing, in fabrication, or in transit. (b) Charge for material used—U-235 and U-238 consumed and U-238 converted to plutonium.

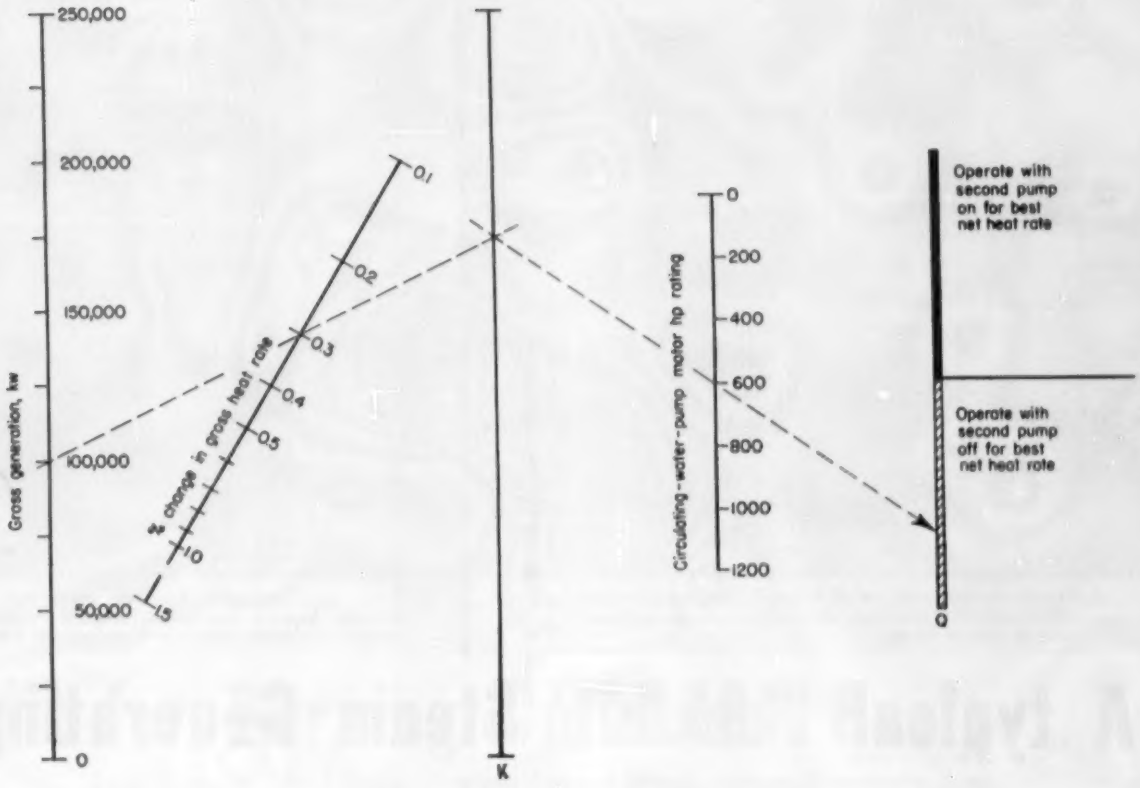
2. Processing includes cost for processing radioactive, spent fuel elements requiring remote-operated plant for recovery of unused U-235, U-238 and of plutonium produced in reactor core. This also includes cost for processing "blanket" elements to recover plutonium and unused U-235 and U-238.

3. Fabricating cost for fuel elements and blanket elements. This material might be radioactive during handling.

(*Continued on page* 214)

Power's DATA SHEET

No. 276



When to put on second circulating pump

► MANY STEAM-TURBINE UNITS have two circulating-water pumps for their main surface condenser. Only one need run during the winter with cold cooling-water temperatures. During the summer's high water-temperature period the second pump should be run to get better vacuum; this improves the station over-all heat rate.

In the spring and fall there will be one temperature of cooling water where it makes no difference whether the second pump runs. Below this temperature, running the second pump reduces over-all plant efficiency because the pump-motor input exceeds the additional generator output produced by the better vacuum. Above this temperature the reverse holds true.

This nomograph will help you figure what to do if you have the heat-rate correction chart that is supplied by the manufacturer for your unit.

The nomograph is based on this formula:

$$\text{Net kw change} = \frac{0.746\,M}{0.9} - \text{gross kw}\left[\frac{100C}{100+C} \times \frac{1}{100}\right]$$

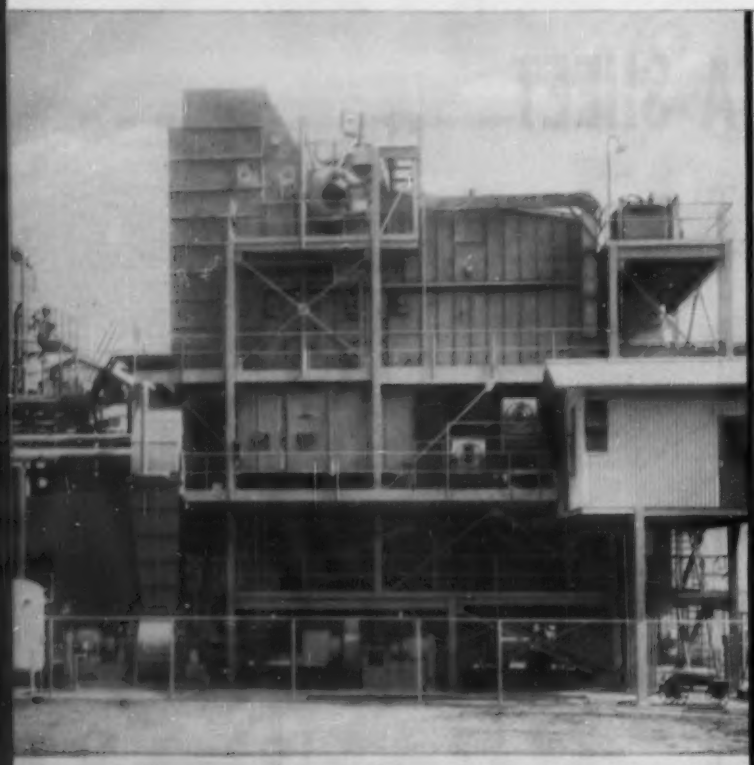
where M is circulating-water pump motor output in hp
C is % heat-rate correction for vacuum change
0.9 is allowance for 90% motor efficiency

To use the chart:

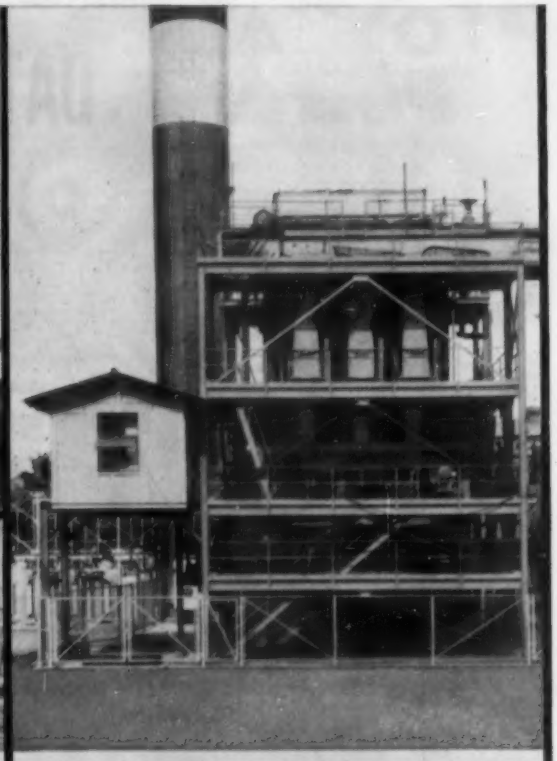
1. Add or take off second circulating pump.
2. Note change in condenser backpressure (vacuum).
3. Find the corresponding percent change in unit heat rate from the manufacturer's curve.
4. Draw a line on the chart from the gross generation scale through the percent change in heat rate to intersect blank scale K.
5. From this intersection draw a line through the pump hp scale to right-hand scale Q.
6. If the last intersection is on the upper half of the cale, put the second pump on the line for best net heat rate—that is, there is a net increase in station output for constant-heat input.
7. If last intersection is on lower half of scale, take pump off for best net heat rate.

CHARLES B SCHUDER — *Metropolis, Ill.*

POWER pays $35 for each Data Sheet accepted. Why not submit yours today?

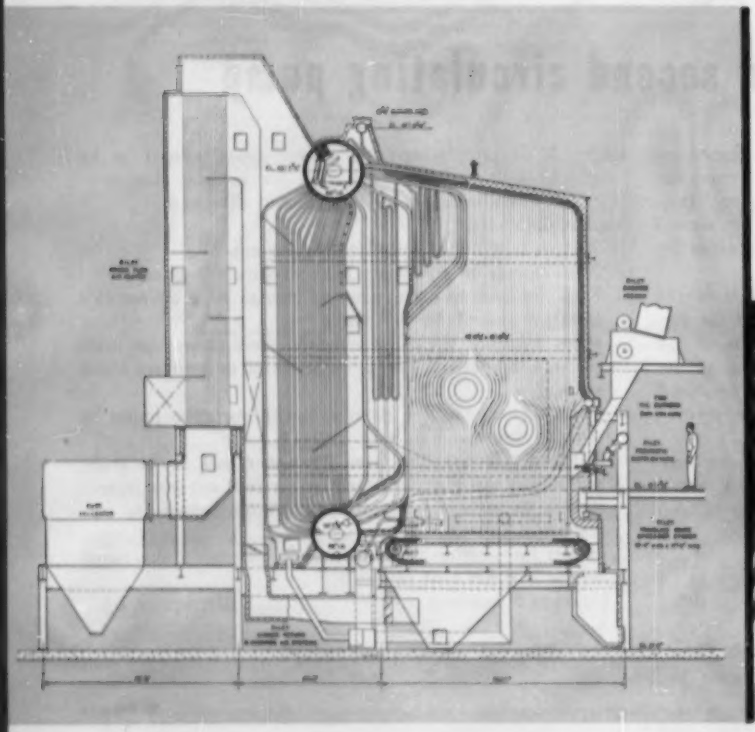


1. Everything outdoors; small house is the control room and shelter for operators. Auxiliary oil burners can be seen at left of house.



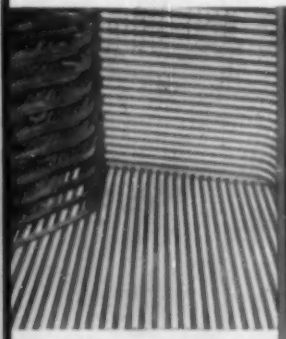
2. Front view illustrates compact arrangement of bagasse burning equipment: bagasse conveyor, feeders, pneumatic distributors, stoker, ash hopper.

A typical RILEY Steam Generating



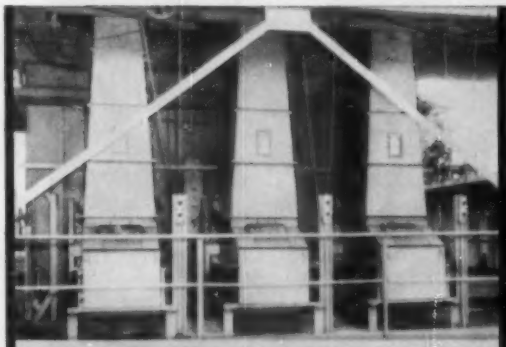
Hawaiian Commercial & Sugar Co.
Puunene, Maui, T. H.
Bechtel Corporation, Consulting Engineer

Capacity 125,000 lbs/hr rated on Bagasse
900 psig — 760 F.
Riley Traveling Grate Spreader Stoker
Three Riley Pneumatic Refuse Fuel Distributors
Three Riley Refuse Fuel Feeders
Four Oil Burners
Overfire Air System
Complete Automatic Combustion Controls

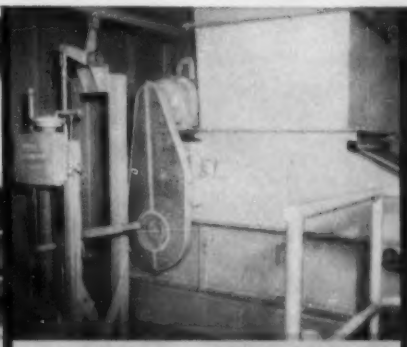


Partial view of furnace illustrates water-cooled slag screen, roof and side wall.

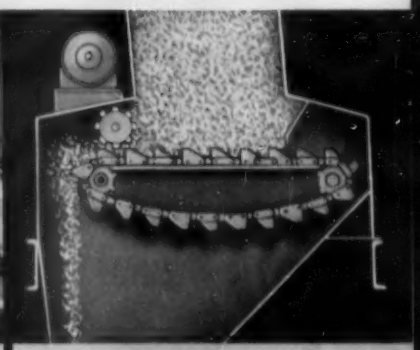
Compact Riley Hydraulic Drive powers Riley Traveling Grate Stoker smoothly.



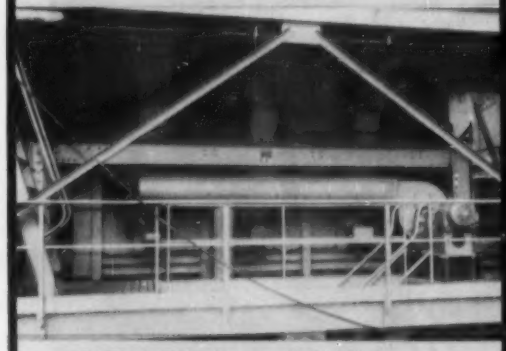
3. Three Riley Refuse Fuel Feeders with individual controls and storage hoppers.



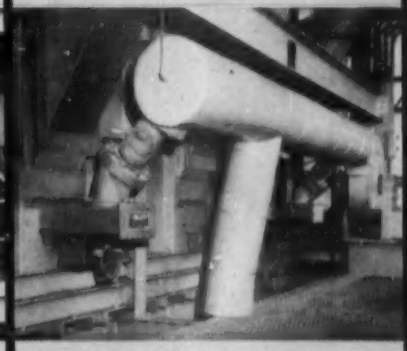
4. Combustion controls regulate feed rate with load demand.



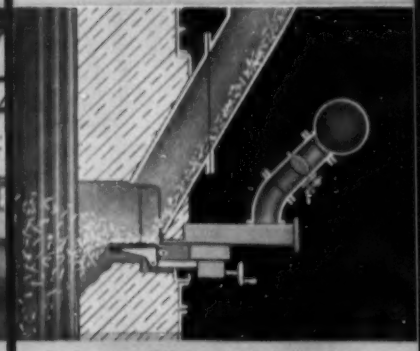
5. Chain type feeder carries bagasse forward where it is shredded by conditioner roll.



6. Three Riley Pneumatic Distributors are simple in design and easy to regulate.



7. Pneumatic Distributors have no moving parts for stringy refuse fuels to wrap around or clog.



8. Bagasse falls to tray of distributor where air jet propels and spreads it uniformly over grate surface.

Unit for Burning Cellulose* Fuels

***Bark, Bagasse, Wood Chips, Sawdust, Hogged Wood, Selvage, Rice Hulls, Sisal**

Modern methods and equipment in the production of steam are as important to year-end profits as any phase of the production process. In the sugar industry progressive, cost-conscious companies, such as Hawaiian Commercial & Sugar Company, are adopting the most efficient equipment available to them for the burning of bagasse, the sugar industry's combustible cellulose waste fuel. Riley's equipment makes steam production almost completely automatic, permits continuous uninterrupted operation throughout the production season, and assures low cost, dependable and efficient operation.

Whether your steam capacity and pressure requirements are large or small, Riley's refuse burning system can be tailored to your needs. Ask your Riley representative for complete information about Riley's refuse burning equipment.

A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs.

RILEY
Stoker Corporation
WORCESTER, MASSACHUSETTS

Boston, New York, Philadelphia, Buffalo, Washington, Pittsburgh, Cleveland, Detroit, Chicago, Cincinnati, Charlotte, New Orleans, Atlanta, St. Louis, Kansas City, St. Paul, Tulsa, Houston, Denver, Salt Lake City, Los Angeles, San Francisco, Portland, Seattle.

Call In Your Nearest Riley Representative

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P. H. Nichols & Co.
903 Whitehead Building

NEW ORLEANS, La.
Riley Stoker Corporation
504 Pan-American Bldg.

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William A. Powe
Obispo No. 61, Habana

COLOMBIA
C. E. Halaby & Co., Ltd.
Edificio Bemaga
Medellin

VENEZUELA
Oficina Tecnica Stubbins
Apartado No. 7, Caracas

MEXICO and CENTRAL AMERICAN REPUBLICS
Andres Araujo y Cia.
S. de R. L.
Avenida Morelos No. 31
Mexico, D. F.

AUSTRALIA and NEW ZEALAND
Riley Dodds Australia Ltd.
636 Swanston Street
Melbourne

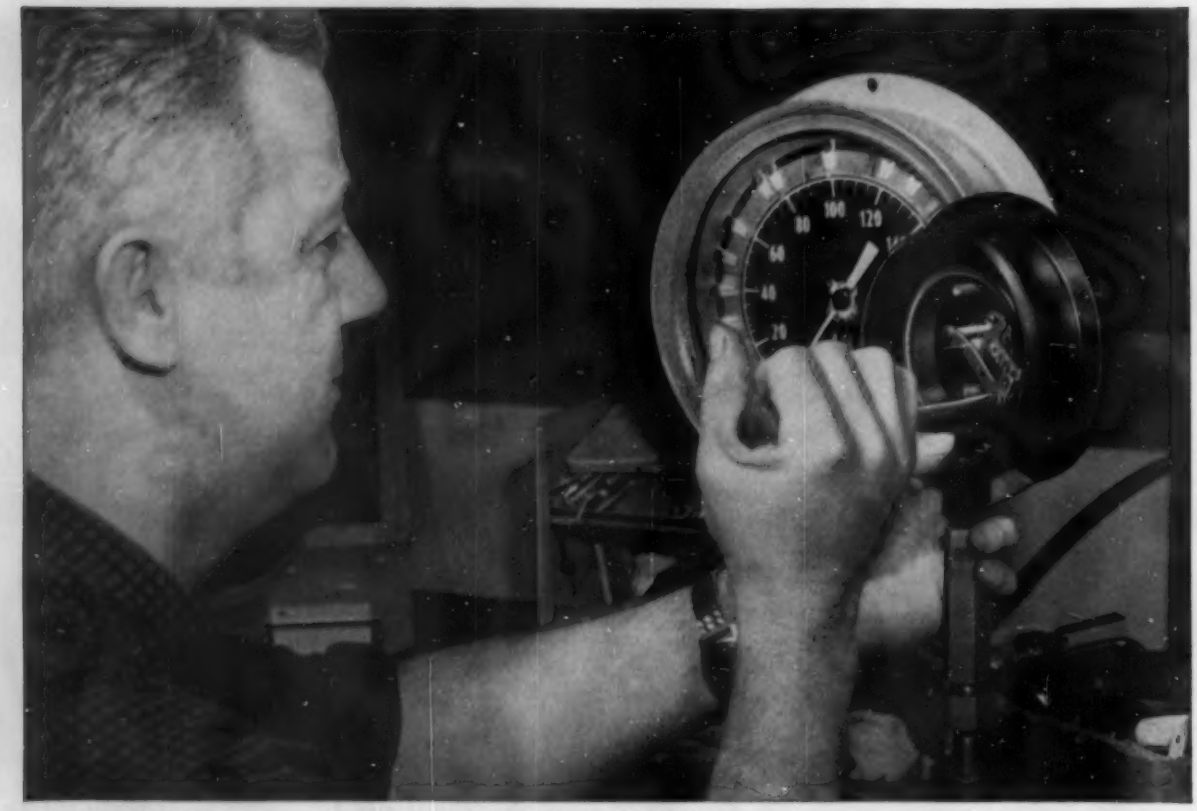
PUERTO RICO
Abarca Warehouses Corp.
San Juan, P. O. Box 2352

HAWAII
Electric Steel Foundry Co.
Honolulu, P. O. Box 1920

MAURITIUS, Port Louis
Rey & Lenferna, Ltd.

TAIWAN (Nationalist China)
William Hunt & Co. (Intern'l) Inc.
93 Chung Shan Rd., North
Taipei, Taiwan

REPUBLIC OF THE PHILIPPINES
Atlantic Gulf and Pacific Co. of Manila
Robert Dollar Building
Manila, Philippines



Accurate gauge — accurate setting. Worker calibrates a pressure gauge equipped with a "K" Monel Bourdon tube at the Manning, Maxwell and Moore plant in Stratford, Conn. The company was the first to use long-lasting, corrosion-resisting "K" Monel for Bourdon tubes in a pressure range of 15 psi to 100,000 psi.

For high-pressure, high-temperature service

Gauges with "K" Monel Bourdon tubing ideally suited to meet today's needs

Can your gauges stand up to higher operating pressures, higher temperatures, and corrosion?

Ashcroft gauges made with Bourdon tubing of "K"® Monel can! Successfully used in a pressure range of 15 psi to 100,000 psi, they may be the answer to your problem.

Like all Inco Nickel Alloys, "K" Monel is strong . . . tough . . . corrosion-resisting. In addition, it has the low hysteresis and drift needed to assure gauge accuracy, and the good fatigue strength necessary for long-term service.

In short, "K" Monel helps bring to your gauging equipment hairline accuracy . . . trouble-free performance . . . and extended life. *Check for "K" Monel Bourdon tubing in the gauges you buy.*

And remember that "K" Monel — or one of the more than 50 other Inco Nickel Alloys — may provide the answer to some of your other equipment problems, too. Particularly if those problems involve high pressures, high temperatures, and corrosion. For any help you need in making a selection, don't hesitate to call upon Inco's Technical Service Section. They're always glad to work with power plant men on specific problems.

Meanwhile, Technical Bulletin T-9, containing valuable material on *Engineering Properties of "K" Monel,* may prove helpful. Write us for a copy.

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

More POWER for you . . . with "K" MONEL INCO TRADE MARK **NICKEL ALLOYS**

STEVE ELONKA
Associate Editor in Charge

Leslie E Clover, manager of plant engineering and maintenance services, General Electric Co, explains how . . .

He selects maintenance men

Editor's note: Second in a series on selecting and training maintenance and operating personnel. See "Selecting Plant Personnel," Dec 1954, pp 125, 126, 127. Look for "Personnel Testing Methods" in very near future.

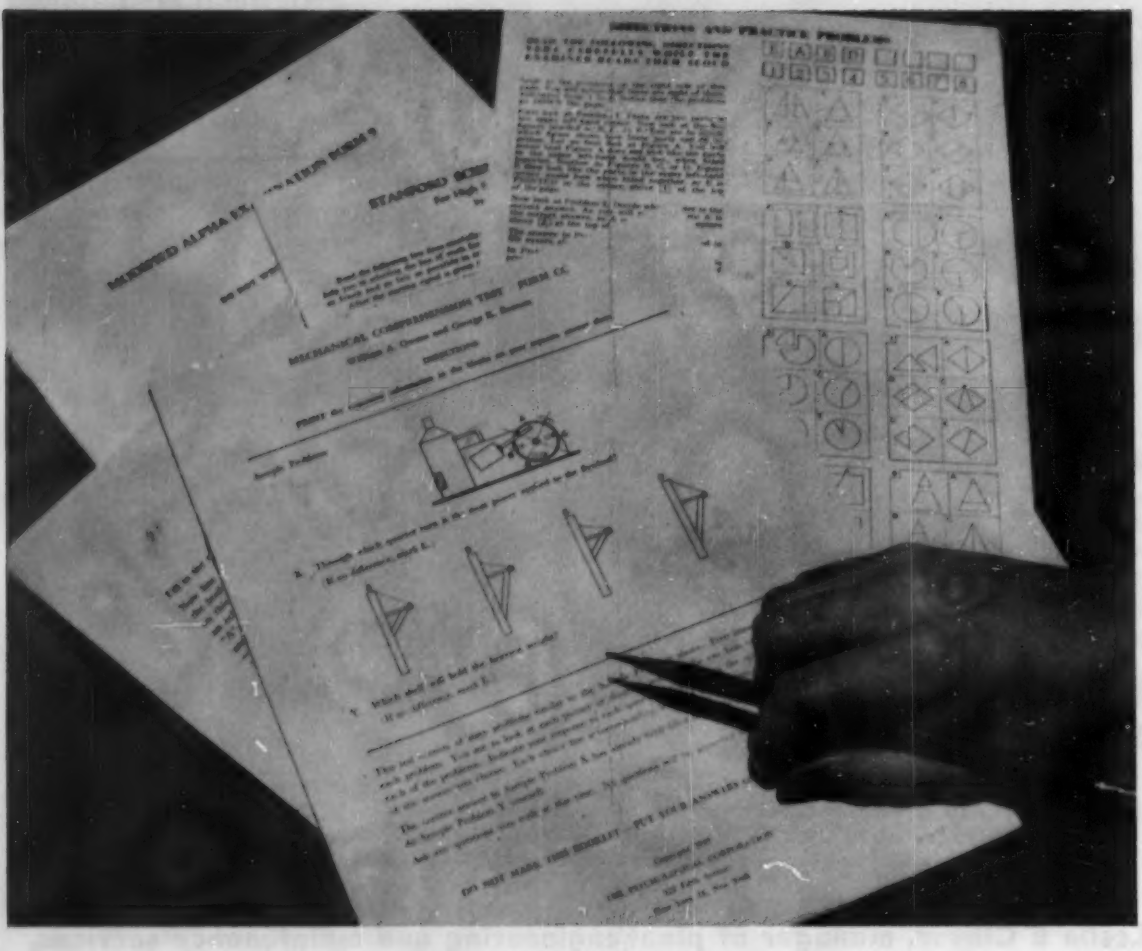
► LIKE URANIUM, raw recruit is where you find him. But there's no Geiger counter to show us a hot prospect. So we test and assay raw materials—manpower from which maintenance people develop. Here's how GE does it.

Qualifications. Age, 17 to 30. Youngest are just out of high school, no experience, need major training program. Older ones have some experience, ability, but need a few special courses.

Excellent health. Pass physical examination. For some jobs, minor physical ailments are no handicap. But a maintenance man often handles tough jobs. Electrician may work high up on crane circuits, down in tunnels on pump motors, in hot boiler room or foundry. During break-down emergencies he may be on the job 16 to 24 hours at a stretch. So prospects must be on the rugged side.

Mentally alert. With the complex automatic machinery, electronic controls and new treatment processes of today and tomorrow, recruits must have intelligence, initiative and sound thinking. Reviewing candidate's school record is a good way to learn his over-all mental capacity.

Sound character, personality. These traits are standard for all jobs, but important for a maintenance man. Why? Because he's on his own most of the time. Often he's the only person in a



Interviews, tests, training are part of the picture

position to observe equipment's true condition. He must know that failure to tighten loose switchgear or replace worn bearings may cause damage. And he must do job beyond schedule, even if production department gives him trouble. He must have guts to make a complete report for management's decision. Maintenance men also work with outsiders—men from machine-tool and equipment builders. Friendly mechanics learn from these people, but "sour-puss" types aren't given much information.

Aptitude and attitude. Mechanical *aptitude* can be measured fairly well. Some men have more than others. Our prospect must rank high in this characteristic. His *attitude* should be, "What can I contribute to my job, my firm, my fellow employe?" Not, "What's in it for me?"

Having found men, either through a hiring office or through supervisors, we then spell out steps they *may* take to become an electrician, steam fitter, machine repairman, etc. I say "may take" and not "must take," for from here on you can only provide *climate* for self-development. GE does furnish classrooms, machines, materials, etc, as well as instructors—also, support of top supervision. But what comes out as a finished product depends on individual.

We allow a fairly wide age range, so let's work out programs on individual basis. Here's typical apprentice program of our maintenance shops.

Apprentice course. Qualifications: (1) between 17 and 20 years of age, or Armed Services veteran under 25. (2) five feet, four inches tall or over, with no serious defects; pass physical. (3) high school or equivalent; including two semesters of algebra, two of geometry, and four of science. (4) good character, and must come well-recommended.

Application instructions. (1) Fill out application form in ink. (2) certified copy of high-school grades. (3) letter from high-school principal, two from other sources. (4) if everything's OK, call for examination, interviews.

Entrance tests	*Minutes*
Work adaptability	15
Mech apprehension (Bennett BB)	30
Mech ability (MacQuarie)	15
General clerical (reading)	10
Temperament (Guilford-Zimmerman)	40
Total time: about 2 hours	

Apprentice selection. Committee chooses applicants for course. Selection is on past performance, results of entrance tests, personal interview with committee.

Classroom instructions prepare apprentice to do a particular job better, also teach him basic engineering. In-

structors are GE engineers, department heads, and specialists whose theory is based on practical know-how and experience. Classes are held at night, 9 hours a week for six 14-week terms. See table below.

Pay rate. Pay is weekly, with a raise at completion of each 850-hr work period. There are eight of these periods. Start is $1.425 per hour and finish $1.785 per hour. We don't pay for classroom time, nor do apprentices get incentive pay.

Expenses. Apprentices pay their own living and transit expenses. We provide training equipment. Drafting instruments, hand tools and miscellaneous items are paid by payroll deductions. Courses approved for Veteran benefits.

Graduation. Completing classroom and on-the-job training, graduate receives diploma, pin and a $100 bonus.

Future progress. Many graduates are now superintendents, general foremen and foremen. Others are in planning and tool design. Some continued training, and now are design, application or service engineers.

Apprentice graduates are also eligible for Company-Wide Manufacturing Training Program. This prepares men for top-level supervision or specialization in factory operations, plant engineering, production and purchasing. That's OK for a machine repairman, but what about an electrician? Electrician trainee follows basic apprentice program, except his on-the-job training is as electrician helper. He also takes special electrical courses, either outside or from us. In license locations he must pass exams before he's recognized by pay or as a fully qualified electrician.

Since GE's apprentice program is slanted toward mechanics, draftsmen and patternmakers, we've had shortages of good electrical repairmen. If this condition occurs when qualified men cannot be hired, plant sets up special course within maintenance force. Steam fitters may be trained same way.

Big problem today is finding electricians for electronics, and pipers (or mechanics) for hydraulic systems. Run-of-mill electrician or mechanic hasn't background, nor desire for needed know-how. So we have special programs, with separate classifications and higher pay rates.

Older maintenance trainees often have some technical schooling, so we bypass classroom work. Besides on-the-job assignments, we use training programs which equipment manufacturers conduct, by enrolling older men on time-and-expense-paid basis. These men usually look beyond immediate craft job, hope to become higher-rated technicians, planners or supervisors.

Supervisors. Best mechanic doesn't always make best supervisor, who must have these traits and abilities: (1) loyalty to company and crew (2) fairness in dealing with individuals (3) control of emotions at all times (4) ability to plan and organize work ahead (5) ability to pass out deserved praise (6) ability to point out poor work when justified, explaining why and how job should have been done.

Supervising craftsmen is no snap assignment. Job needs all help extra training and experience can provide. Plants having "lead hands" or "group leaders" in craft setup can observe how a man performs as a leader before making him a foreman. Where a leader isn't used, we select supervisors in other ways.

If promoted from ranks, what ammunition can you give a man who punches out on Friday as a workman and reports Monday as a foreman?

Training. Set up informal training for supervisors. Pick likely men from gang. Give them special assignments in planning, scheduling, expediting, assisting engineers or other jobs to acquaint them with office routines and still keep them in occasional contact with their old craft workers. At the same time, give them management-type courses in economics, accounting, production control, labor relations, human relations, etc.

When a supervisory job opens up, your man will be better qualified to run that job. Workmen recognize a supervisor's extra training beyond theirs. They'll remember he can work with tools and knows a reasonable day's work. Also, supervisor becomes used to wearing a suit instead of overalls. Thus he gains confidence from working with management. He also understands the *why* of job to go with the *how*.

Evaluation. Having found a maintenance prospect, provide climate and facilities for self-development into a qualified craftsman or supervisor. Indoctrinate him into policies and procedures of firm, then evaluate him.

Today, harmonious relations come only when management's evaluation is accepted by employes—and employes include supervision as well as shop workers.

So you can measure evaluation of maintenance people by how much you pay them. Their value—like refined metal—is a function of raw-material scarcity and processing needed.

Maintenance craftsmen in GE are paid rates ranging between "machinist classification" and that of first-class toolmakers. Actual rates in one plant are: electrician—$2.295 per hour; piper—$2.295 per hour; carpenter—$2.24 per hour; ironworker—$2.24 per hour; mason—$2.24 per hour.

These are not going rates in the construction trades, but if you add pension, hospitalization insurance, stock bonus-savings plans, etc, (fringe benefits) you have the full answer. We believe maintenance jobs in GE are properly evaluated.

Future needs in maintenance seem obvious to us. There are many encouraging signs that top management, often vaguely referred to as "THEY," is aware of problems. But THEY are WE. *Tomorrow* we will be replaced with better men. Therefore, if we don't already have a well-spelled-out plan for selecting, training and evaluating maintenance people, GET ONE STARTED SOON.

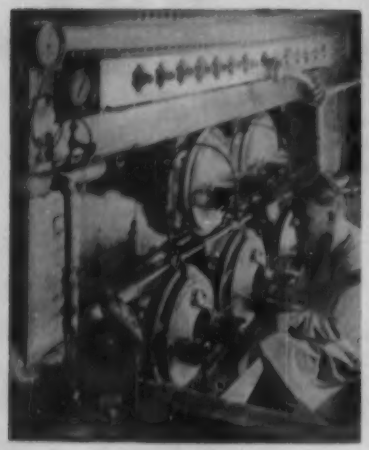
Classes for on-the-job training

Apprentice completes course in 3½ years. This includes 6800 hours of on-the-job training, also 750 hours of night-school classes in subjects below:

Classroom subject	*Hours, week*	*Classroom subject*	*Hours, week*
Shop mathematics	3	Mechanical drawing I	2
Advanced algebra	3	Mechanical drawing II	2
Trigonometry	3	Mechanical drawing III	2
		Tool design I	2
Physics I	2	Tool design II	2
Physics II	2		
Mechanics I	2	Economics of industry	2
Mechanics II	2	Industrial policies & methods	2
		Materials of industry	2
Strength of materials	2	Engineering English	2
Electricity—dc	2		
Electricity—ac	2	Machine-shop lectures I	2
		Machine-shop lectures II	2
Metallurgy	2	Machine-shop lectures III	2
Blueprint reading	2	Machine-shop lectures IV	2

OPERATORS' NOTEBOOK 86

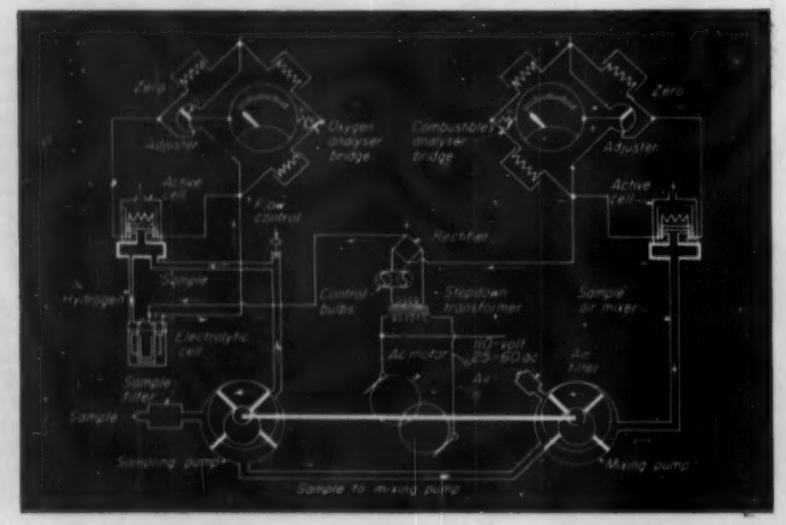
Save fuel and your product



STEAM BOILERS. Boilers that generate power or process steam usually have CO_2 recorders for controlling combustion. But power engineers know that a high CO_2 reading alone isn't proof of efficient combustion. To get the full story, you must also check for presence of unburned gas. Instrument shown takes readings in last boiler-pass to check accuracy of your CO_2 recorder. It also shows completeness of combustion. Charts and tables supplied with instrument find exact combustion efficiency. These charts and tables also show exact CO_2 and excess air in combustion products. They are easy to use.

STEEL FURNACES. Open hearth furnace, steel industries' largest fuel user, has many operating variables. Furnace deterioration causes air to leak in. Variations in fuels and other combustion components also give more trouble. Waste-gas analysis measures over-all effect of these variables. This instrument gives information for adjusting furnace controls. It analyzes gases, disregards fuel variations and isn't affected by gases from the charge. Continuous indication of oxygen and combustible content allows operator to make correction at all ranges of fuel flow needed for top efficiency.

CERAMIC, REFRACTORY KILNS. Steady flow of high-quality product through kilns is important in making brick, refractory and abrasive products, pottery and porcelain. Kiln's atmosphere has a direct bearing on product's quality. So for more accurate control, nature of atmosphere must be correct in all portions of kiln that work passes through. Here instrument serves as accurate, time-saving combustion tool to check atmospheres in vicinity of work, or in all parts of kiln, for that matter. For this service, instrument helps bring each burner into right combustion alinement. Readings can be taken by furnace operators.



Wheatstone-bridge

► GONE ARE THE DAYS of guessing at combustion efficiency by glancing at character and color of flame in furnace, measuring temperature and then looking at smoke coming from stack. Today, we depend on instruments to control combustion components: fuel, air, temperature and pressure. But you must make chemical gas-analysis to check efficiency of control process.

Heat prover shown is portable, weighs 25 lb. It has sampling tip and hose, with thermocouple for measuring temperature. Instrument operates from an ac power source, 110 v, 25-60 cycles. It analyzes gas sample for oxygen and

dollars with better combustion

By STEVE ELONKA,
Associate Editor

GLASS TANKS. Total fuel cost to operate modern glass tanks is very large. And, of course, economical generation and application of heat calls for efficient combustion practice. Here, again, production rates and product quality benefit from precise control of glass-tank atmosphere. Problems before combustion engineers in glass industry are like those of open-hearth fuel engineer we tell you about in second item here. Correct control settings are found from analysis of tank gases. So here, again, this instrument accurately analyzes combustion products in the presence of contaminating gases of the bath.

INDUSTRIAL FURNACES. Heating and heat-treating furnaces in metals and metals-processing industries need right combustion. Reason: Work is in direct contact with combustion products in many industrial furnaces. So burner controls must be set to produce oxidizing or reducing atmosphere in line with metallurgy of furnace product. These furnaces cover wide range in size, construction. Material is usually put in one side and comes out other, ready to process. Air-fuel ratio is generally regulated with temperature regulator. Quality of oxidizing or reducing atmosphere is important, making instrument invaluable.

CEMENT KILNS. Cement is highly competitive and cost per barrel depends largely on fuel used for process. As in steel and glass production, combustion products are diluted with the gases evolved from the chemical reactions within the kiln. So direct analysis for oxygen is needed to evaluate excess air in waste gases. In general, burners are adjusted to low oxygen and for zero combustible content. Oxygen analysis and check on combustion efficiency guide the kiln operator. It helps him set his controls so he saves fuel, yet operation is efficient, troublefree. Again, charts and tables show exact efficiency.

circuit measures resistance change

combustible-gas content. Percents by volume of these sample gases are shown continuously and simultaneously on instrument meters.

Steady flow of sample is drawn into instrument by rotary pump. After passing through filter, pump delivers sample simultaneously to both oxygen and combustible analyzing sections.

Sample flowing into combustible section is mixed with air and pumped through the active cell of combustible analyzer. Hot platinum-wire catalyst, suspended inside cell, forms one arm of a wheatstone-bridge circuit. Air-sample mixture burns at surface of wire, increasing its temperature and electrical resistance in proportion to volume of combustible gas in sample. This change in electrical resistance is measured by wheatstone bridge. Bridge meter is calibrated to read directly in *Percent Combustibles.*

Sample flowing into oxygen section is mixed with hydrogen generated in electrolytic cell. Hydrogen-sample mixture passes into active cell of oxygen analyzer. Any oxygen in sample burns with hydrogen at surface of cell's platinum wire. Wheatstone-bridge circuit again measures change in electrical resistance of cell wire. Bridge meter here is calibrated to read in *Percent Oxygen.*

Oxygen and combustible meters have both 4% and 20% scale ranges. Dual-range feature affords greater instrument accuracy and sensitivity. Oxygen meter has additional scale for measuring output of instrument thermocouple in degrees F.

Operation is entirely automatic—all parts housed in unit. Scale ranges are selected by operating range switches below each meter. Instruments are checked periodically against calibrated cylinders of laboratory-analyzed gases by firm lending the instrument.

—Courtesy, Cities Service Oil Company

FIRE DETECTION: These five automatic devices spot plant fires fast

The sooner you detect a fire in your plant, the better your chance of putting it out before a conflagration gets under way. Here's a look at a new fire-detection system, plus review of principles used in many systems that are common today

By **ALTHEA THORNTON**, *Assistant Editor*

► WITH THE ADVENT of the new ionization-chamber principle of fire detection, there are at least five distinctive agents for detecting fire:

(1) Ionization chamber, revealing the presence of products of combustion or smoke by changes in conductivity (2) photoconductive cell, operating on radiation and flicker present only in open flame (3) electric eye, actuated when (a) light is reflected from smoke particles onto a photoelectric cell—the reflecting principle, or (b) smoke interrupts a light beam to a photoelectric cell—the blocking principle (4) pneumatic tube or bulb, operated when temperature rise expands a fluid medium, usually air (5) thermostat, actuated when heat expands or melts a thermally sensitive element. Here's how each of these systems works:

Ionization-chamber detectors use a highly sensitive gas-discharge (cold-cathode) tube and two independent chambers. These units are combined into a detection head. One chamber is exposed to atmosphere, the other is virtually sealed (see sketch). A minute source of radioactive material mounted in each of the chambers ionizes the air.

Adjustment provides balanced voltage in each chamber when there is no combustion gas or smoke present. But the system becomes unbalanced when gas or smoke appears because these elements influence the conductivity of an ionization chamber. The exposed chamber rapidly changes condition, makes the cold-cathode tube electrically conductive and a relay sounds the alarm.

Note that an air-temperature rise has no effect on operation of the unit. Depending on the setup, the control panel can also be wired to alert the public fire department, close fire doors, activate extinguishing systems, or perform other functions.

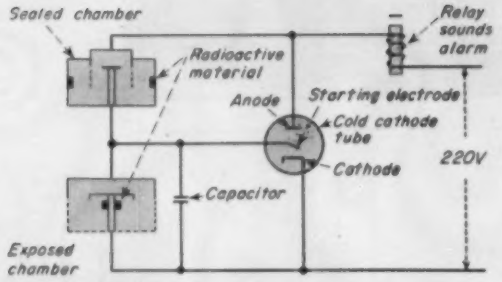
Photoconductive-cell detectors operate on the principle of modulated radiation by flame. The cell picks up the varying radiation and flicker emitted by the flame and sends a pulsating signal to the control panel, which actuates the fire-warning system. Within the control panel, pulses below six and above 30 cps are rejected to discriminate fire from extraneous radiation from the sun, incandescent lamps, etc. The optical filter covering the cell (see sketch) keeps out visible light, passing only infrared radiation.

This unit does not have to see the flame directly to set off the alarm. It can detect a fire from both reflected and direct radiation, as well as from radiation transmitted through glass.

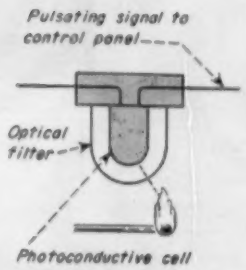
The cell is not set off by heat. It operates entirely on radiation from the flame, but strong light decreases its sensitivity to fire. Fluorescent lamps, however, have negligible effect. Each detector must be located to permit unobstructed scanning of the entire area it is intended to protect, with due consideration of the screening effect of room contents.

Electric-eye smoke detectors operate on the change in photoelectric current that accompanies a change in light intensity on a photoelectric cell or cells. The current change operates a relay that causes a smoke-alarm signal.

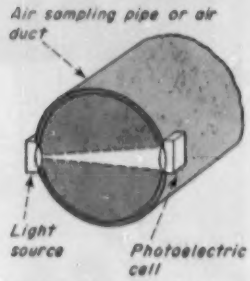
Light source and photoelectric cell may be located (1) in the protected area or (2) in a special smoke chamber. In the second setup, a continuous air sample is pulled from the protected



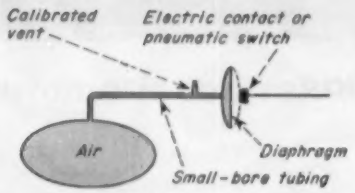
IONIZATION-CHAMBER DETECTOR. Radioactive material makes chambers electrically conductive. Voltage is balanced between them when there is no fire. Combustion gas or smoke causes electrical unbalance between the chambers, energizes cold-cathode tube; alarm sounds



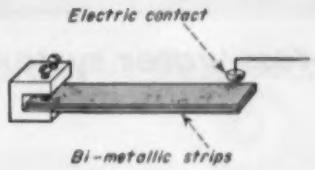
PHOTOCONDUCTIVE CELL picks up varying radiation and flicker emitted by flame, sends signal to control panel that actuates the fire alarm



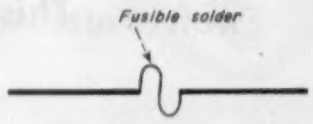
ELECTRIC-EYE smoke detector. Alarm sounds if smoke cuts down light received from source (above) or increases reflection to the cell (p 122)



PNEUMATIC SYSTEM. Air in bulb or tubing expands, creates pressure against diaphragm, which makes electric contact or throws a switch. The vent prevents operation from normal temperature changes



THERMOSTAT makes or breaks contact, operates electrical alarm. Types may be fixed temperature, rate of rise, combination, or rate compensated. Both spot and continuous-line types can be obtained



FUSIBLE SOLDER melts at predetermined temperature, sets off alarm. This is a type of thermostat, must be replaced after each operation. Fusible links to close fire doors work on same principle

area by a blower, and drawn past the sensitive cell.

Effectiveness depends on good engineering of the installation, location of the detecting units and air-sampling equipment. Periodic maintenance is essential to keep lenses, photoelectric cells and light sources clean, and to keep motors running continuously where necessary.

This is the third type of fire-detection system that does not depend on heat for actuation. The remaining types, pneumatic and thermostat, are operated by the heat of the fire.

Pneumatic system ordinarily operates on the rate-of-rise principle. This means that the alarm sounds when rapidity of temperature rise exceeds a predetermined rate, usually 15 to 20 F per minute.

Individual installations can be either (1) spot type, where sensitive bulbs or globes and diaphragms are spotted at specified distances apart on the ceiling or roof, or (2) continuous-line type, in which small-bore tubing is fastened to ceilings or walls in continuous loops or circuits, with diaphragms at ends of the tubing runs.

When air in bulb or tubing expands, it creates pressure against the diaphragm, which makes electric contact or throws a pneumatic switch to sound the alarm, set off extinguishers, etc. A small compensating vent permits air to seep slowly in or out of the tubing, and prevents operation from normal temperature changes.

Rate-of-rise systems can be used alone, or in combination with fixed-temperature devices, which are designed to operate when temperature reaches or exceeds a certain value.

Rate-of-rise systems are usually more sensitive than fixed-temperature elements, especially where incipient fire may cause a rate of temperature rise fast enough to operate the unit appreciably sooner, sometimes several minutes before temperature at the ceiling would operate fixed-temperature units.

Thermostats are often fixed-temperature detectors, although some manufacturers provide units that operate on the rate-of-rise principle. Another type of thermostat is rate compensated. In effect, it provides rate-of-rise plus fixed-temperature operation, but is more sensitive as the temperature is increased.

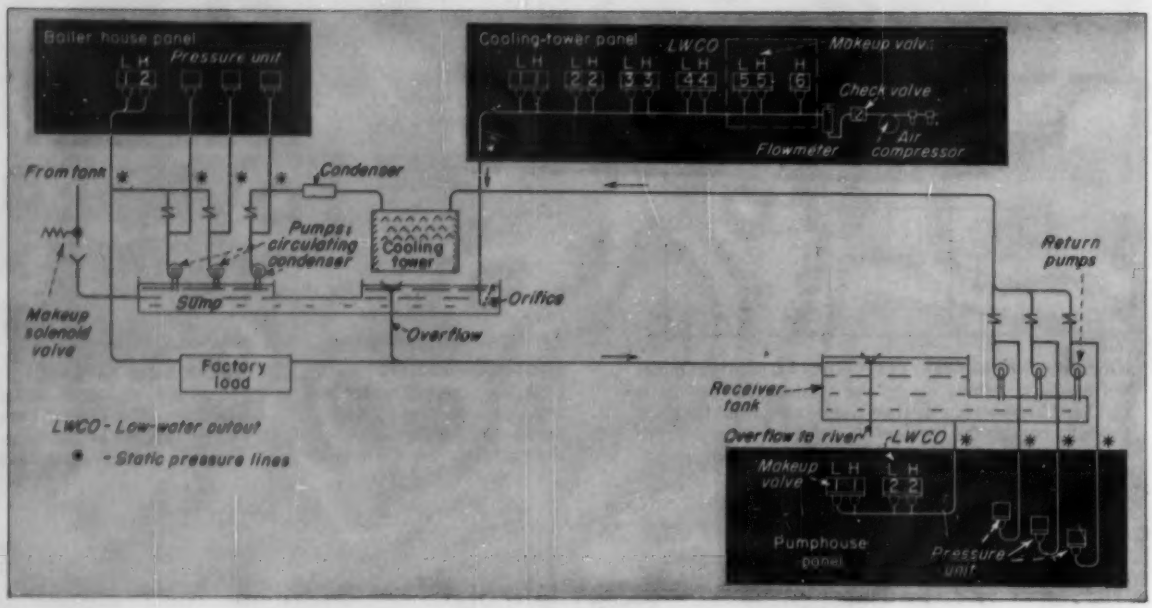
Many thermostats can operate repeatedly without replacement, while others cannot be re-used and must be replaced, once they have operated.

In a simple, reusable, spot-type, fixed-temperature thermostat, bimetallic strips expand and bend on application of heat, making or breaking an electrical contact at the predetermined temperature. This sounds the alarm. Rating frequently corresponds with sprinkler-system rating.

In a single-operation spot-type unit, a quartzoid bulb bursts or a fusible solder melts to open or close circuit.

With line-type thermostatic cable, a plastic coating between two conductors melts at the predetermined temperature, wires make an electric contact, and the alarm sounds.

Fixed-temperature devices do not need as much attention to minimize the danger of false alarms as do rate-of-rise units. In addition, they operate in slow smoldering fires that do not increase room temperature fast enough to operate rate-of-rise devices, set for a relatively rapid temperature increase.



This process-water system has . . .

Use automatic controls for better water distribution

You can improve the pressure and flow conditions in your water system and at the same time reduce pump wear. Tips here show you how to get good controls

By TOM PROBST
Automatic Control Company

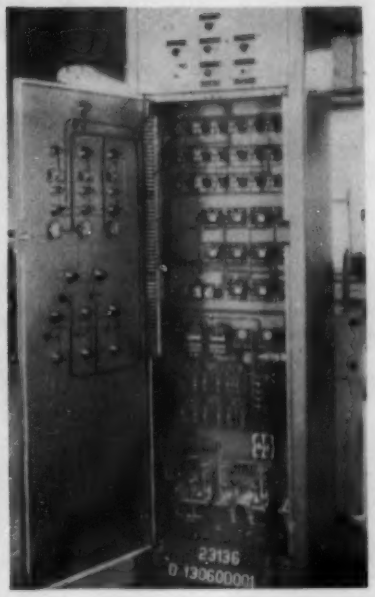
► EVEN WITH many pump designs available, plant and municipal engineers run into trouble supplying water in right quantities and pressure for industrial processes and city population. Manual control is unsatisfactory in starting and stopping pumps and regulating pressure because it is almost impossible to get the desired flow when water demand fluctuates.

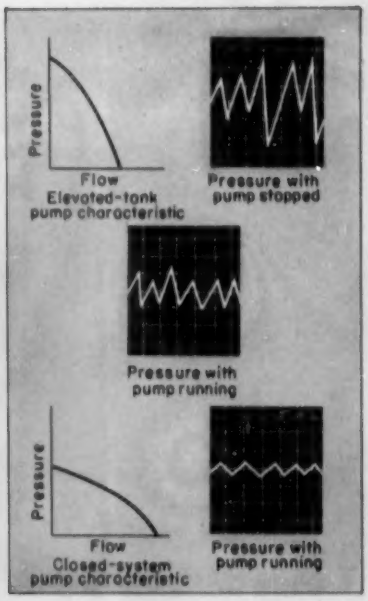
Automatic controls are accordingly assigned today's job of anticipating pressure and quantity. Infinitely more accuracy results from regulating these conditions automatically.

Installation at Hamilton - Standard Division, United Aircraft Corp, Windsor Locks, Conn., is typical. Three panels automatically control water-supply and pressure conditions for the large industrial cooling system, above. Controls start and stop circulating and condenser pumps to maintain normal pressure in the main water supply.

Also controlled are the starting and stopping of the return pumps. These take water from the receiver tank and discharge to the cooling tower. Correct sump level is always maintained.

Third function of the control is to monitor operation and provide indication and alarm signals. These tell what is happening to each unit at all times.





automatic controls to give the desired . . . pressure, flow

Advantages. Control maintains pressures continuously. It reduces the number of times the pumps must start to meet supply or pressure needs. Power to keep system in operation is reduced. And with fewer starts and stops, there is less wear in the pumps.

Other control designs are available. One type, at Camp Irwin, Calif., is unusual. It (1) automatically controls operation of a number of deepwell pumps discharging to a reservoir, and a series of booster pumps supplying elevated storage tanks from the reservoir (2) provides an automatic power-demand cutoff, preventing pump operation during peak power demands.

This system's built-in alarm features give visible and audible signals of power or pump failure or low-level conditions in reservoir or storage tanks.

Choosing controls is much easier when the power engineer tries to see the problem from a control engineer's viewpoint. Also, operation is likely to be better.

Objective of most pumping systems is to take water from some source and deliver it to specified outlets at a given rate. An elevated tank may have water pumped directly into it, with the distribution system beyond the tank. Or distribution system may lie between the tank and pump. Or you may use a combination of the two.

Pump selection factors remain the same, no matter what type system is used. Capacity is determined by the demand or size of the system. Pressure that the pump must develop is a function of the total head of the system.

In choosing a pump, power engineers figure the total head, add a safety factor and call the job finished. Calculations are based on what happens while the pump operates. Pressures in the system while the pump is stopped are usually of little concern to the power man.

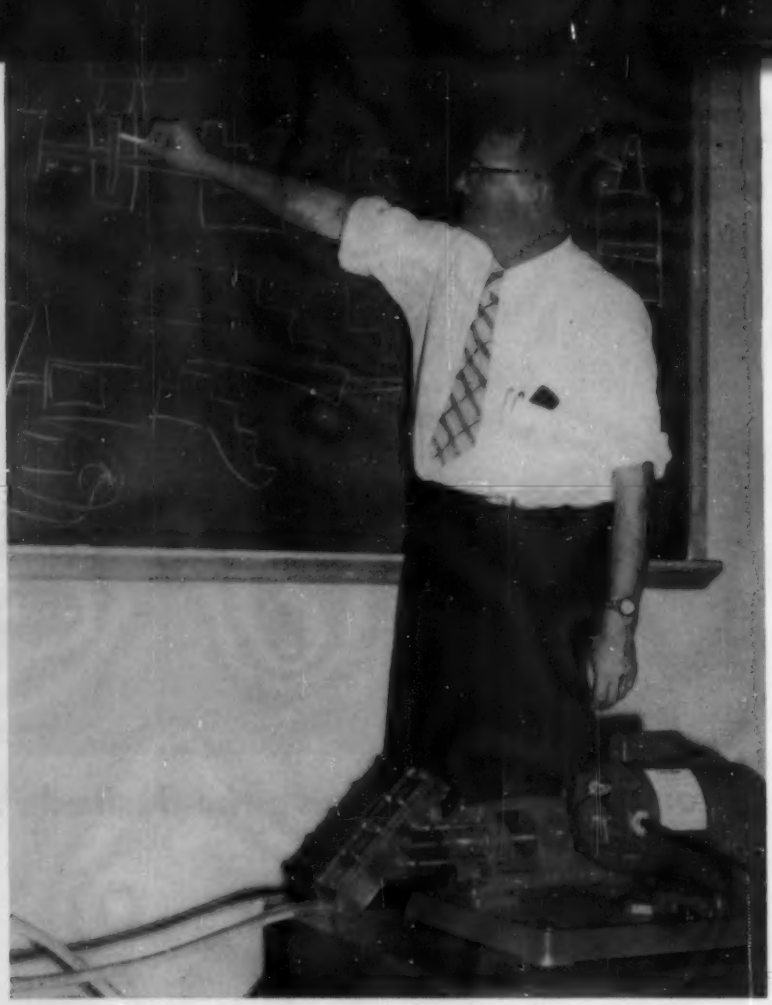
Control engineers, however, are concerned with all phases of the operating cycle. They must design to start the pump automatically when water in the tank drops to a certain level, and stop the pump when water reaches the overflow point. Pressures during operation and shutdown are of equal importance in the control engineer's calculations. Pressure-sensitive control devices must detect drop in static pressure, indicating need for pump operation and increase in pressure to point where pump must be stopped.

Pump characteristic curve is important in any system, whether control is automatic or manual. In an elevated-tank system during periods of pump shutdown, tank supplies demand and pressure chart resembles that shown, above right. With pump operating, magnitude of the pressure surge is reduced as shown, because the pump characteristic curve takes up the slack in demand variation causing the surge.

Steeper-curve pump generally used on elevated-tank systems reduces the surge somewhat. But a flatter-curve pump absorbs even more fluctuation and, other conditions being equal, reduces the running surge still further, as shown.

Suction-pressure changes that cause pump characteristic curves to shift deserve consideration in pump choice. Where broad suction-pressure ranges exist, a control is sometimes fitted to sense the pressure. Control divides pressure into definite zones to provide smooth operation. Changes in system friction curve provide initial actuation for control.

Since it does not pay to put more power into a pump than is needed at any given moment, the range of demand to supply must also be evaluated. This prevents operating a larger pump than necessary during off-peaks. A large pump running at part capacity usually has a lower operating efficiency.



Take these simple steps to . . .

Calibrate your chemical-feed

► OPERATORS AND ENGINEERS don't usually think of chemical-feed pumps as instruments, but that's exactly what they are.

When, for instance, you read a pressure gage that indicates 30 pounds, you're sure the pressure actually is 30 pounds because you take for granted that the gage has been calibrated right. The situation is much the same with chemical-feed pumps. They'll measure and deliver a controlled volume of liquids—usually a chemical solution—to your boiler drum or mixture tank. But how do you know it's actually delivering the liquid volume needed? You take for granted that its calibration is OK—or you can calibrate it.

Calibrating techniques boil down to finding out whether the pump is handling a specified volume of liquid per minute, hour or other convenient time unit. Flow rates are usually low enough to be measured in gallons per hour.

Common way to check calibration on a controlled-volume pump is to measure draw-down of liquid in the suction tank. Another method depends on setting a small calibrated tank on the suction line and measuring time needed to pump a specified liquid volume from the tank. In either case, you compare pump rating, at the stroke length you're using, with calibration results.

A fast, accurate method to get the same info is to operate the pump against the relief valve in the discharge line. Before starting pump on test run, close hand shutoff valve on the discharge line. Pumped liquid then discharges from the relief valve.

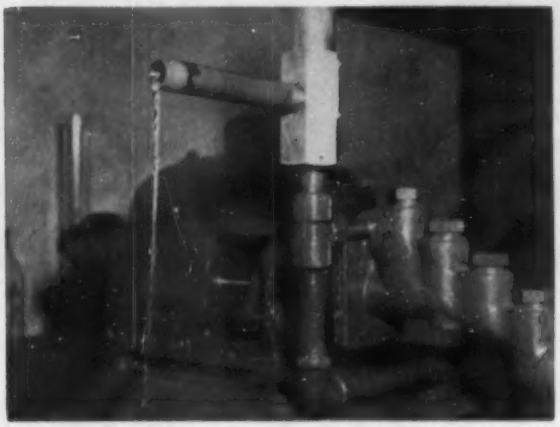
How method works. Photo sequence above shows, in simple steps, how this method works. After operating pump against the relief valve and measuring liquid volume for a definite number of pump strokes, follow through with figuring shown in table, p 127. To get theoretical pump capacity, multiply plunger area, sq in., by stroke length, in. Then multiply this result by number of strokes you use during test. Result is pump's theoretical capacity, cu in.

Chemical-feed pumps never yield full theoretical capacity. Liquid compressibility, packing leakage and slip—the slight loss in valve seating—all tend to trim down pump delivery. Ratio between actual capacity, from test shown in photos, to theoretical capacity, is volumetric efficiency (ve).

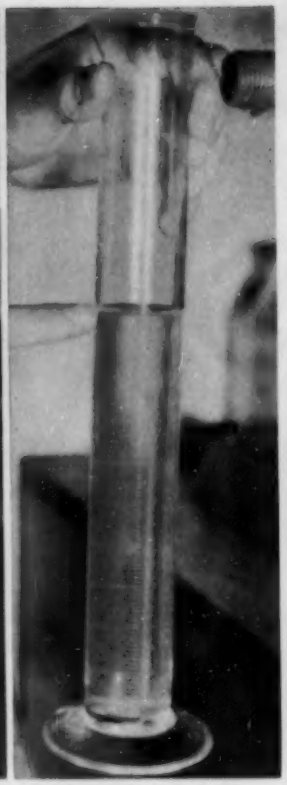
Ve varies with pump size and the liquid you happen to be pumping. In smaller pumps, where capacity is about 25 gph, at pressures less than 1000 psi,

Based on sessions at 5th Instrument Maintenance Clinic, given by B S Bertolet, service manager, Milton Roy Company. Sponsored by the Instrument Society of America.

1 To run calibration check, operate pump against relief valve. Before starting pump, close shutoff valve in discharge line



2 Controlled-volume pump, shown here, discharges the liquid from relief valve after discharge valve is closed. Measure this flow for a specified number of feed-pump strokes



3 Graduate cylinder can be used to measure the volume flow directly. During test run, pump actually delivered 140 milliliters. Use these data to figure ve, in the table below

pump, figure its efficiency

you should be able to get ve's of 85% or better, based on pumping water at room temperatures.

If ve is low, take a good look at the valve, valve seats and packing. If these are OK, check suction line for plugging. Here's an easy method: Disconnect suction line at the pump inlet. Connect inlet, through a hose, to a bucket of water. Run calibration test again. If you get a substantial ve boost, look for an obstruction in the suction line—or air leakage.

Pressure failure may be due to: (1) wear on valve seats or ball checks, or both (2) dirt on the valve seats or ball checks (3) air leakage at suction line or at stuffing box (4) partly open relief valve (5) low suction pressure. If, after making needed adjustments or replacements, your pump still doesn't build up to right pressure, you'll do well to check with the manufacturer.

Controlled-volume pump calibration

Plunger diameter—7/16 inch 3-inch stroke
Plunger area—0.15 square inch

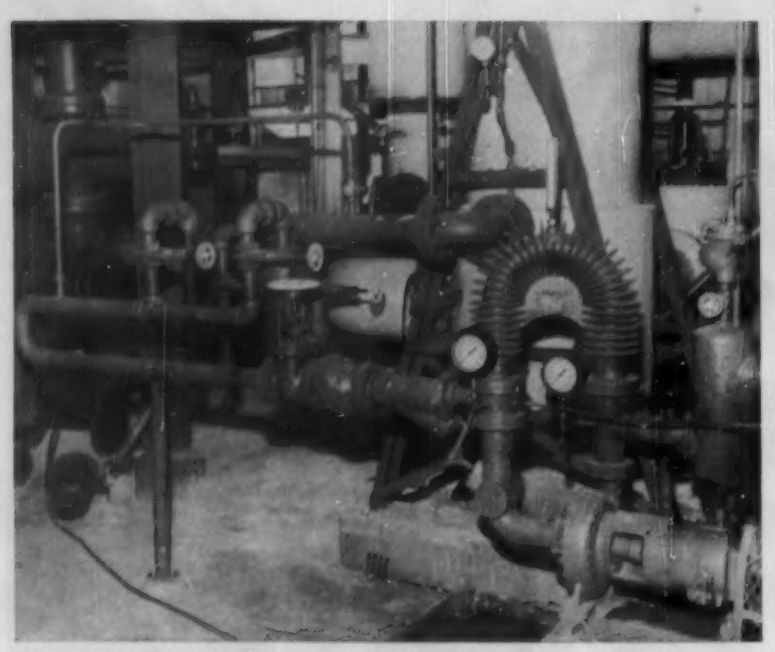
0.15-sq-in. sectional area × 3-in. stroke = 0.45-cu-in. displacement per stroke.

0.45 cu in. × 20 strokes = 9 cu in. or 147.5 milliliters theoretical capacity.

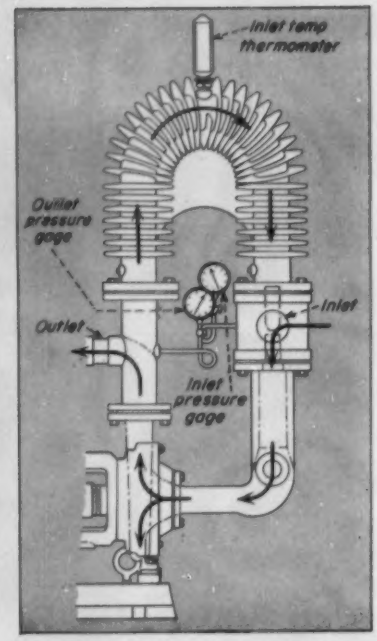
Liquid volume actually collected in 20 strokes was 140 milliliters.

Volumetric efficiency = 140 ÷ 147.5 = 95 percent.

This volumetric efficiency should be within ± 1 percent repeatable accuracy.



1 One of five 25-hp jet pumps draining digesters in a paper-manufacturing plant. An inverted-bucket-trap arrangement is used for standby, discharging to waste



2 Finned priming loop used in the combination jet and the centrifugal pump

Step up condensate removal and heat

You can increase the production rate of steam-process units and reduce steam costs by using suitable equipment and the right hookup. Here are the details of one widely used method

By R M JOOS, *Cochrane Corporation*

► EVERY YEAR steam-process equipment manufacturers spend much time designing units to give better output and products. Plant operators, too, know that correct operation of modern equipment is essential for best output. Both know that efficiency of equipment that transfers heat by conduction to a product depends on rate and percentage of the heat transfer.

Heat transfer in a process cycle, which is the rate of imparting latent heat of steam to a product, causes the steam to condense. The heat-transfer coefficient fixes the size of a unit for a given production rate.

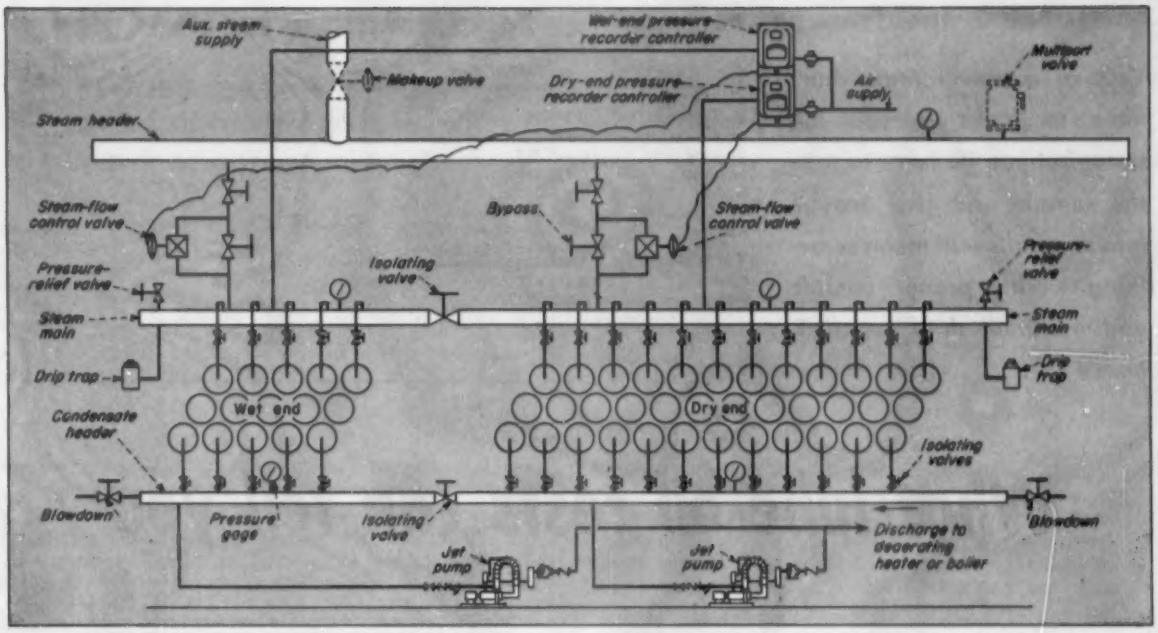
Condensate removal affects the heat-transfer coefficient—the more effective the removal of liquid and gas, the better the coefficient. Traps are commonly used for condensate removal from process units. Highest heat-transfer rates are obtained with traps that can release the greatest amount of gas with the condensate from the equipment. Reducing the amount of air and condensate film in a heat-transfer device raises the heat-transfer rate.

Tests show that under certain conditions as little as 1.5% of air in steam can reduce the capacity of steam-condensing equipment by as much as 75%. To keep gaseous and condensate films at the minimum possible, the most desirable vent rate must be used.

Steam-trap orifices are sized for this best vent rate. But intermittently operating traps will not drain continuously. Continuous-drainage traps do not always give best venting under all condensing conditions.

Combination pump, jet and centrifugal, Fig. 1 and 2, developed in recent years, is used with many steam-process units. Pump draws water from a finned priming loop, Fig. 2, discharging to the loop and an outlet point.

There is a venturi-shaped jet tube



3 Steam and drainage hookup for a 2-section paper machine fitted with two jet pumps, one for each pressure level. The jet pumps operate without traps because the paper siphons are sized to prevent excessive steam volumes at venturi jet

transfer with good drainage control

on the suction side of the finned loop. Control valve on the outlet maintains a designed differential pressure across the jet tube to give the desired condensate and gas removal. Returns enter the venturi throat. Jet tube and pump are sized for maximum condensate load; this occurs during start up.

Amount of condensate discharged to the outlet equals the quantity of liquid and steam entering the jet. From the outlet the condensate flows to an intermediate point in the boiler makeup system or to the feedwater header.

Condensate temperature is close to the saturated-steam temperature in the process equipment. Finned loop, always flooded with condensate, has a float-operated vent trap to discharge noncondensables handled by the jet condenser.

Radiation loss reduces temperature of the condensate arriving at the jet to a few degrees less than that of the saturated steam in the process equipment. When jet is primed, no steam can pass through the venturi tube except what the jet stream condenses. This is less than 1% and gives best vent rate.

Finned loop is designed only to radiate the heat imparted by the circulating pump. With process equipment operating at 100 psig, pressure at venturi jet is about 10% less, plus pump-casing pressure. Temperature of condensate in finned loop is about 330 F.

Full process pressure and saturated temperature are always maintained in condensing chambers during increased latent-heat needs when faster speed or reduced operating time is desired. To prevent excessive steam flow to the venturi jet with multiple condensing equipment, inverted bucket traps are sometimes used in condensate-return lines. These are sized for the full pressure-drop differential and never close, giving continuous modulated flow of condensate, gas and air to the jet.

Two prime objectives of proper drainage are obtained with this system—adequate continuous venting to insure minimum condensate film and maximum air elimination, and high back-pressure and temperature head against the condensing medium.

Another advantage is direct return of condensate at nearly saturation temperature to boiler or condensate system. This gives a closed system without flash loss or temperature reduction.

Applications. This system is applied to every known type of steam-process equipment. Fig. 3 shows two pumps of this type applied to a paper machine. In recent years, over 340 machines and corrugators have been drained.

Note that a jet pump is needed for each section of the dryer because the operating pressures are different. In the 2-section machine shown, the pumps operate without traps because the paper siphons are sized to prevent excessive steam flow to the jet.

While the arrangement shown is typical, many others are possible, depending on the requirements of the process units.

Other process equipment, to which jet pumps are applied, includes corrugators, coil kettles, jacketed kettles, unit heaters, platen presses, heat exchangers and miscellaneous special units. Proper condensate drainage in these, as well as other units, insures maximum heat transfer, upping production while reducing steam cost. This, of course, is the aim of all plant operators today.

You, as a power man, don't have to make lube-oil lab tests—but you do have to take the sample and give enough info so results will mean something. With proper sample and pertinent data supplied, here's . . .

Table I: Schedule of tests for used oils

Test	ASTM designation	Turbine & hydraulic	Circulating	Gear	Spindle	Engine: Gasoline	Engine: Diesel
Gravity, deg API	D-287-52	x	x		x		
Flash point, F	D-92-52						x
Viscosity	D-445-53T	x	x	x	x	x	x
Insolubles	D-893-52T			x		x	x
Water	—	x	x	x	x	x	x
Ash	—			x		x	x
Neutralization No.	D-974-53T (color ind) / D-664-52 (potentiometer)	x	x		x		x
Color	D-155-45T	x			x		
Dilution	D-322-35					x	x

What lube-oil tests can tell you

By C W NICHOLS, *Technical Service Dept Socony-Vacuum Oil Co, Inc*

Table II: Significance of changes in test results

Test	Decrease	Increase
Gravity	1. Admixture with heavier-grade oil 2. Oxidation 3. Insolubles	1. Admixture with lighter-grade oil 2. Fuel dilution
Flash	1. Admixture with lighter-grade oil 2. Fuel dilution	1. Admixture with heavier-grade oil
Viscosity	1. Admixture with lighter-grade oil 2. Fuel dilution	1. Admixture with heavier-grade oil 2. Oxidation 3. Insolubles
Insolubles	1. Deposition in system 2. Addition of makeup	1. Increased contamination 2. Increased oxidation 3. Corrosion 4. Wear
Water	1. Settling in system 2. Evaporation	1. Contamination
Ash	1. Loss of additive 2. Addition of makeup	1. Contamination 2. Wear 3. Corrosion
Neutralization No.	1. Addition of makeup	1. Contamination 2. Oxidation
Color	1. Addition of makeup	1. Contamination 2. Insolubles 3. Oxidation
Dilution	1. Addition of makeup 2. Mechanical correction	1. Increased fuel contamination

► WHY GET lubricating-oil laboratory tests? Among the reasons for checking lubricant characteristics, these are the most important: (1) See that new oil meets supplier's guaranteed characteristics. (2) Determine suitability of lubricant for further use. (3) Establish drain periods. (4) Find cause for abnormal change of lubricant performance. (5) Determine reasons for equipment failure.

These reasons for tests are all important from the operator's viewpoint. But he doesn't usually take the tests himself. A trained laboratory staff does that. There are, however, certain steps the operator can take to insure that the test results mean something.

Taking a sample. To start with, the operator taking the sample should make sure it is representative. To determine what a representative sample is, keep in mind the purpose for testing the lubricant (one of the five reasons for tests, above). For instance, when it is desired to determine the suitability of a lubricant for continued service, the sample should be taken while the equipment is in operation and from a point that insures it is representative. For a turbine, the sample should come from some point where the oil is in circulation.

Put the sample in a container that cannot possibly contaminate it. Clean cans for petroleum products are best.

So the laboratory analyst can come up with the best possible answer to your specific problem, he must have the pertinent factors relating to it. Give him all possible operating data and explain the problem. Then the analyst can use the information in interpreting his test results—and you benefit by getting the best answer.

What tests? There are a number of lubricant tests given in *ASTM Standards on Petroleum Products*. The nine most commonly used tests are listed in Table I, along with schedule of tests for various systems. Table II gives brief summary of what variations from new oil may mean. Examples on facing page give analyst's tests and interpretation for various lubricant problems. Examples 1 and 3 determine suitability, Example 2 sets lubricating-oil drain period, and Examples 4 and 5 deal with poor lubricant performance.

This article is adapted from paper presented to the New York Section of the American Society of Lubrication Engineers.

Five examples give analyst's test, interpretation for lubricant problems

Example 1: Analysis of used turbine oil

Reason for analysis: To obtain a periodic check on condition of the oil

Test	New oil	Sample A 60,000-kw turbine	Sample B 175,000-kw turbine
Gravity, deg API	31.0	30.4	28.4
Visc at 100 F, ssu	150	159	180
Color	1	5 (cloudy)	3
Neut No.	0.02	0.62	0.05
Sediment, %	Nil	0.20 (largely oil oxy-products, some iron rust)	Trace
Water, %	Nil	0.10 (fresh)	Nil

Example 1: *Sample A* appears cloudy because of appreciable contamination with water and sediment. Moderate increase in neutralization number indicates some internal change in the oil. Viscosity has increased accordingly.

If water leaks into oil, it may result in formation of stable emulsions and rust, and hasten oil oxidation. The leak should be found and corrected. Sediment shows presence of oil oxy-products and rust.

Remove water and sediment and this oil will be satisfactory. With proper purification, its use may be continued.

Sample B has lower gravity, higher viscosity and darker color than new oil. From this, we might say oil has deteriorated. But neutralization-number increase is small and sediment negligible. We conclude, then, that the oil has been contaminated with a heavier-grade product.

Example 2: Used diesel engine oils

Test	New detergent type	Sample A 6 cyl, 2300 hr	New non-detergent type	Sample B 2400 hp, 2-str cyc
Viscos: 210 F, ssu	68	68	62	59
Flash	—	—	420	380
Dilution	Nil	4.0	Nil	2-4
Neutralization No.	—	—	0.05	0.56
Pentane insolubles	Nil	1.9	Nil	0.2
Benzene insolubles	Nil	1.7	Nil	—
Water, %	Nil	Nil	Nil	Nil
Ash, %	0.60	0.93	Nil	0.02
In ash (spectrographic): Major	Additives	Additives, lead		
Minor	—	Iron		

Example 2: *Sample A* has reached acceptable limit of insoluble and ash-forming content. Most of insolubles are lead compounds from fuel and sooty matter from engine combustion chamber. Some fuel dilution is also present. Viscosity appears normal—but this results from the thinning effect of fuel compensating for the thickening effect of insolubles. Oil in this sample is unsatisfactory for engine use. It should be drained as soon as possible.

Sample B. Low flash point indicates some fuel dilution, reducing viscosity. Dilution is estimated at 2 to 4% from viscosity decrease. Other tests are satisfactory. Neutralization number is OK, indicating no excessive internal change. No water is present. Insolubles and ash contents are all right. Ash shows small amount of iron from normal engine wear. Oil is suitable for further service.

Example 3: Used gear oil

Test reason: Check for the suitability of this oil

Test	New oil	Used oil*
Viscos: 210 F, ssu	105	122
% insolubles, benzol	Nil	0.08
% water	Nil	Nil
% ash	2.00	1.96
In ash (spectrographic): Major	Additives	Additives
Minor	—	—

*Approximately six years service

Example 3: Viscosity has increased to next viscosity grade because of prolonged service. But oil is relatively free of local contaminants as shown by absence of water and low insolubles content. Ash shows compounding materials are at normal levels. No evidence of gear wear is found in this sample.

To restore this product to its original viscosity, lighter gear oil of the same quality can be added as makeup. The amount can be determined from viscosity blending charts.

The oil has passed the test for suitability, and its use can be continued.

Example 4: High-temp circulating oil

Test reason: Abnormal product discoloration
Operation: Plastic mill—4-roll calender

Test	New oil	Used oil
Viscos: 210 F, ssu	127	138
Color	7	Gray
Neut No.	0.7	0.7
Sediment, %	Nil	1.8
Nature	—	Largely aluminum flakes and fines
Ash, %	0.12	0.51
In ash (spectrographic): Major	Additives	Aluminum
Minor	—	Additives

Example 4: Abnormal discoloration of this product was due to contamination with aluminum flakes and fines. On the basis of this analysis, an investigation was conducted. Source of contamination was traced to the improper installation of aluminum bearing shields. This resulted in the grinding of these parts and subsequent contamination of the oil with aluminum metal. Correcting the bearing shield installation cleared up the discoloring problem.

Specific purpose of this test was poor performance of oil, made evident by its effect on the product.

Example 5: Used automotive-engine oil

Test reason: Tendency to sludge
Equipment: 6 cylinders, 700-hr service

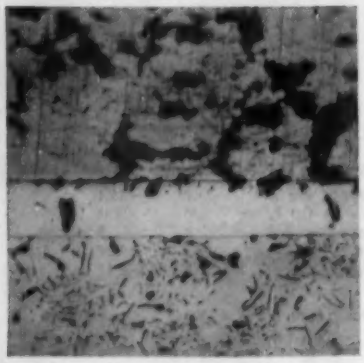
Test	New oil	Used oil
Viscos: 210 F, ssu	54	59
Dilution	Nil	2.8
Pentane insolubles	Nil	1.2
Benzene insolubles	Nil	1.0
Water, %	Nil	1.1
Ash, %	0.62	0.77
In ash (spectrographic): Major	Additives	Additives
Minor	—	Lead, sodium chromium, iron

Example 5: This sample is found to contain an excessive amount of water. This water caused the formation of an emulsion sludge. Sodium and chromium found as minor constituents in the ash are related to water conditioners. Their presence in the oil suggests cooling-system leaks. Since this may result in bearing failures or other engine harm, the leakage source should be investigated and the condition corrected. Results of other tests are satisfactory.

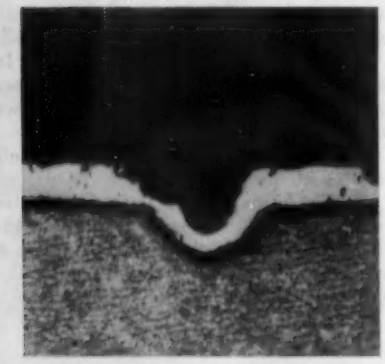
Here, again, the tests were conducted because of poor performance of the lubricant causing engine trouble.

GROUP OF CYLINDERS ranging from 4.5 to 12.75 in. bore in commercial production for plating with porous chromium. Plating operation requires special techniques

Photomicrographs show



1 Surface of honed pinpoint-type porosity and an edge section of the same



5 Edge section of honed chromium surface over knurled surface of Fig. 4

Chromium plating of engine cylinders

You may save many $$ in your plant by using the pointers in this article on porous chrome plate. Proved in aircraft and marine engines, this material is doing a fine job in many stationary engines

By **RUSSELL PYLES,**
Vice President and Chief Engineer
Van Der Horst Corporation of America

► CHROMIUM PLATING of internal-combustion engine cylinders became popular during World War II, especially for submarine and aircraft engines. Now it has wider use in locomotive diesels, marine engines, heavy-duty automotive diesels, and also it is standard on a large number of stationary engines.

Chrome-plated cylinders are favored for heavy-duty high-output continuous-duty service. For lighter service, as in passenger-car engines, chrome-plated piston rings are preferred. Both platings prolong cylinder and ring life.

Advantages. Besides reducing wear rates, chrome plating of cylinder bore increases life of the basic cylinder. When worn, the remaining chromium can be electrolytically stripped from the bore, and the cylinder replated and finished to original dimensions. This can be repeated so long as the cylinder remains structurally sound.

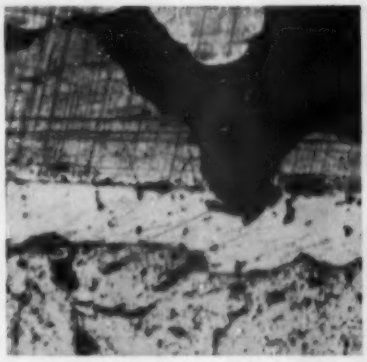
Types. For engines, porous chromium is produced by electrolytic or chemical action on chromium plate on a smooth-honed bore. Or the bore may be pre-roughened, knurled or tooled before dense chrome is deposited on it.

Two types of porous chromium are produced—pinpoint porosity, Fig. 1, and channel porosity, Fig. 2. First type has many microscopic depressions in a honed chromium surface. It is used in all types of engine cylinders except aircraft. Channel porosity is considered the standard type for aircraft engines.

For both types of porosity, projected

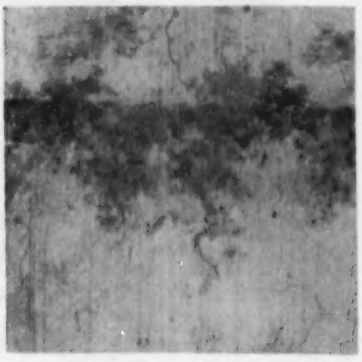
porosity types on different metal surfaces and the effects of service

2 Surface of honed channel-type porous chromium; an edge section of same

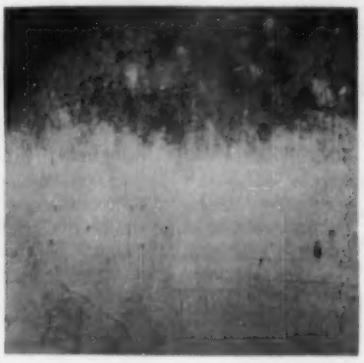


3 Surface of honed chromium plate on preblasted surface; edge section too

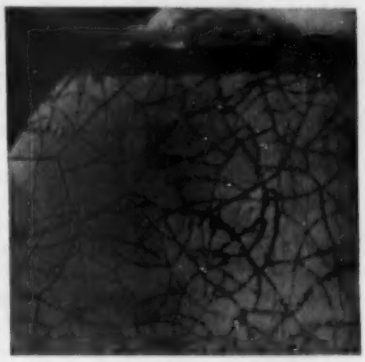
4 Surface of a honed chromium plate on knurled or indented aluminum surface



6 Chrome-moly cylinder after storage; corrosion at position of bottom ring



7 Top-ring position in chrome-moly aircraft cylinder after engine operation



8 Upper end of channel-type chrome aircraft cylinder after 1084 hr use

can slash wear rates, up economy

area of subsurface depressions is 20 to 50% of total area. A low porosity, say 5%, approaches dense chromium and is susceptible to scoring. High porosity, say 75%, may encourage high initial ring wear and high oil consumption.

Depressed patterns of various types may be obtained by shot-blasting, knurling or tooling the bore surface before plating. These bores must be finish-honed after plating to produce ring- and piston-bearing areas. Fig. 3, 4 and 5 show examples of these methods.

Lube conditions. Experience shows that with critical lubrication conditions in the region of top center an interrupted surface is better than a dense one. In normal engine service, porous chrome-plated cylinders give wear rates 1/3 to 1/10 those of cast iron and steel, whether or not they have been heat-treated or hardened. This performance is credited to a number of factors:

1. Interrupted surfaces, inherent in porous chromium, aid lubrication, and act as a scratch-breaker, trapping surface-damaging materials and taking them out of circulation. Damage is limited to small areas that later heal.

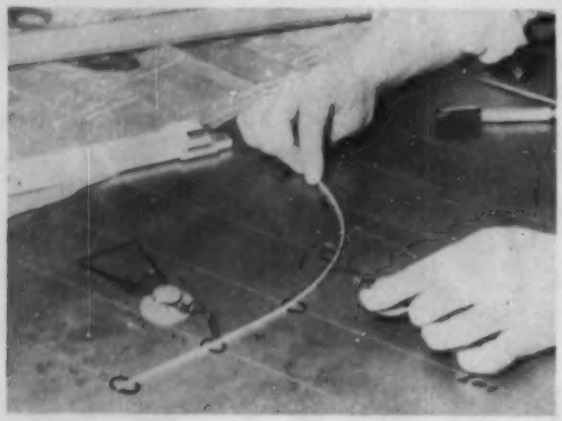
2. Hardness is a desirable attribute of at least one of the moving surfaces. Electrolytic chromium ranks high in this characteristic, having greater hardness than cast-iron cylinder compositions, 4140 steel and nitralloy after removal of surface stock.

3. Thermal conductivity compares favorably with usual cylinder materials. High conductivity of the chrome produces rapid heat transfer from a local damage spot to larger metal masses for dissipation. High surface temperatures are limited to small areas.

4. Corrosion resistance of chromium is superior under most conditions. Damage from sulfuric acid can be minimized by high coolant temperatures, which maintain the cylinder wall above the dewpoint, avoiding condensation. Combustion byproducts enter the exhaust system in the vapor state. The same is true for halogen acids.

Chrome plating can do much for the life of your engine. Why not look over your present wear rates and see if they are excessive? If they are, chrome plating may be the answer to better output.

Latest PRACTICAL IDEAS to help you do a

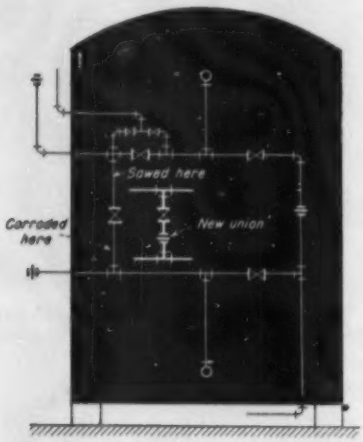


You can make these ducks

TO LAY OUT CURVES you usually need several pounds of lead spline weights, or ducks. But a pocketful of suction-cup ducks made with wire coat hangers will do the job just as well. Besides, you will find that both the expense and the weight will be a lot less.

They work on any slick surface, even one that's slightly porous if you use a little moisture or glycerin under cup. Biggest advantage is that they can be used on vertical layouts—which is more than you could ever do if you were working with any lead spline weight.

E ROBBERSON
Port Washington, N. Y.

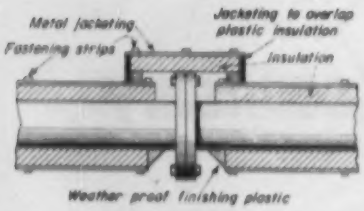


Pipe replacement short-cut

A NIPPLE in our water-softener piping sprung a bad leak. Rather than disassemble the large number of fittings to replace the corroded pipe, we made two cuts about an inch apart in center of nipple. We unscrewed the two remaining stubs and filled in the space with two shorter nipples and a union. In this way we made a quick, easy job of what could have been a long, back-breaking operation to get rolling.

R J ANDERSON *St. Paul, Minn.*

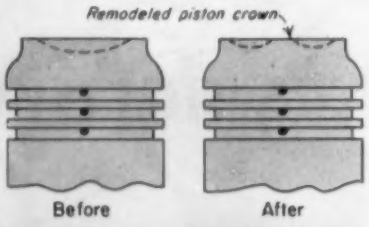
Weatherproofing your outside piping



OUTSIDE PIPING must be insulated and then weatherproofed. Sketch shows method of applying aluminum sheet of 0.020 inch in thickness to the flanges of a pipe.

The top half of the flange is insulated here while the bottom half is not.

COURTESY, CHILDER'S MFG CO
Houston, Texas



No more cracked piston heads, and no more smoke

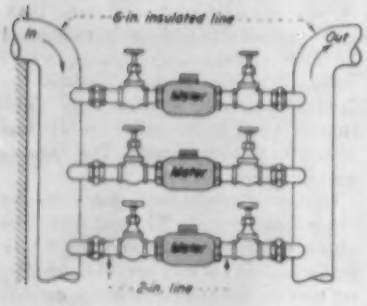
WE HAVE a 55-hp single-cylinder 2-cycle crankcase-scavenging diesel engine. It drives an alternator for our plant's lighting system.

Exhaust from engine was always giving off smoke, although compression was OK. Other engines of this type in the Islands gave the same trouble and piston heads would crack from time to time.

I found that changing piston, as shown in second sketch, stopped the smoky exhaust. Our piston heads have not cracked since making the change.

A CAMACHO *Bogo, P. I.*

Three water meters for one



SIX-IN. water lines are metered inside building. Cost of 6-in. meters is high, fast replacement often troublesome.

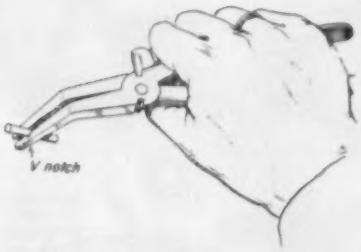
Instead of using one large meter, we hook up three 2-in. meters, sketch. This gives us advantage of a small inventory. Now, we have on hand one 2-in. water meter, which can replace any 2-, 4-, or 6-in. line meters when needed.

B A CROSSON *Cranston, R. I.*

EDITOR'S NOTE: *How about added friction in line from smaller lines. Or is that important enough in this case?*

better job and cut your costs

STEVE ELONKA, *Associate Editor*



Now, small pins are easy to grip

GRIND two small V notches in offset needle-nose pliers to hold small pins, sketch. Notches hold the pins firmly when you're working in tough spots.

C H WILLEY *Penacook, N. H.*

Here's the right dope on piston wear

WARNER'S STATEMENT that pistons usually wear oval from crankshaft misalignment (Feb, p 138) needs some correction. Pistons USUALLY wear oval from normal use. Out-of-roundness is caused by thrust, due to angularity of piston rod forcing piston against cylinder wall on every stroke. It's most pronounced on side taking thrust of expansion stroke because of heaviest unit pressures at this time. Cylinders and pistons show this. Engines with crossheads have wear on slippers and guides.

Crankshaft misalignment on a side-to-side center line of cylinders has little effect. Shaft misalignment of horizontal line would have to be an extreme, as length of rod to fit bearings absorbs a good deal of misalignment before pressure is brought to bear on fore-and-aft line of cylinders.

On one older-make diesel with very short trunk piston, standard practice was to "cock" rod by inserting shims under one side of marine type connecting rod at crankbearing end. This kept the rod from slapping sideways on bearings, also held piston slap down to acceptable levels. I've never heard of any out-of-roundness developing from this. But it's a drastic cure, may cause arguments. I mention it only because it has about the same result as crankshaft slope.

Surely, if main bearings were down enough to cause this piston wear, low lube-oil pressure, due to worn main bearings, would give even more headaches than just piston wear, as Warner says.

J H GRAHAM *Seattle, Wash.*

Don't let this happen to you

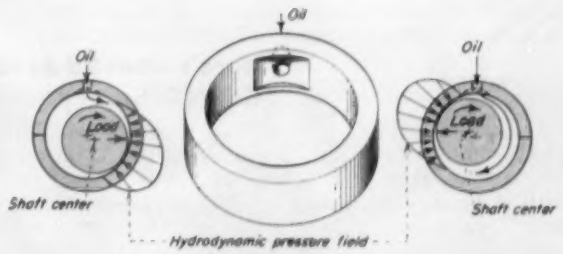
WE HAVE twin buildings with small ammonia refrigerating units to cool drinking water on the roof of each building. Units' head pressures went up, so they were cleaned during the next winter.

The following spring, head pressures were higher than usual, in spite of condensers being cleaned and system operating with very light spring load. Being on the fifth-floor roof, city-water pressure was suspected. So little booster pressure pumps were installed. They just did help carry the load.

I started working at the plant during that summer. Next fall I opened the condensers myself. Each had eight tubes, but I found that six tubes in each condenser were as dry and polished as the day they were cleaned. I could see that only two of the eight tubes had done all the work.

Heads on these condensers were identical castings, with oval recesses for two tubes apiece, one tube for WATER IN, the other for WATER OUT. By turning each head one stud apart, water would flow in series through all the tubes. But the mechanic used the casting number as his mark and put both heads on the same way. Result was that water passed through only two tubes in condenser. Don't let this happen to *you*.

F M ALLEN *W. Sacramento, Calif.*



I'd groove bearing like this

BEARING GROOVES (Dec, p 143) shouldn't normally be in zone where shaft contacts bearing (in direction of load). Instead, place so shaft rotation tends to pull oil into contact zone. Groove in contact zone disturbs hydrodynamic pressure field and reduces load-carrying capacity.

If direction of load is horizontal and load reverses, place groove in top and bottom of bearing. I would try one groove in top only, sketch, extending over about ¾ of bearing length and over about 60 degrees of circumference. Horizontal split is not desirable here because of bearing lubrication. If split, make chamfers in split as small as you possibly can.

Use helical groove if speed is very slow, and dirty oil is the problem. Apply hydrodynamic theory of bearing lubrication: *Machine Design*, August 1953, "Nomographic Method for Sleeve-Bearing Design."

W K JEKAT *Harrison, N. J.*

(*Continued on page* 136)

More PRACTICAL IDEAS

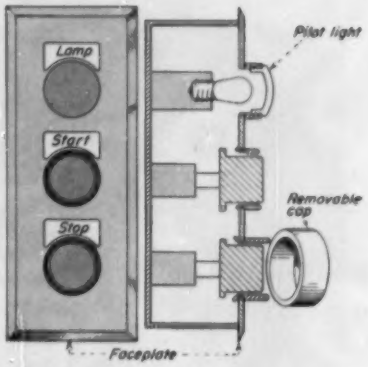
Begins on page 134

Soft hammer face doesn't burr metal

SMALL MACHINE PARTS may be damaged when being hammered together. So give your machinist hammer a soft face by placing a rubber socket over its head. Rubber tip, in photo, is from a crutch. This type socket, or cup, is also used for bottom ends of tubular furniture's steel legs.

Shape of rubber cap in photo is distorted because it has to fit tight to prevent slipping off during use. Another handy use for rubber-faced hammer is bending sheet metal in jaws of bench vise. Metal won't dent if it's hammered with rubber tip instead of bare-metal head hammer, makes neater job.

C T BOWER *London, Eng.*



Protect your pushbutton stations

GUARDS on instantaneous-type pushbutton stations prevent accidental shutdowns. These can happen during construction work in a power plant if a person accidentally bumps a stopbutton. Operator may not notice immediately.

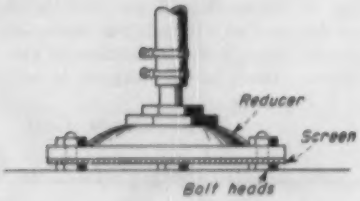
As some switches are located away from operator's station, he can't always watch switches. Because stopbutton is part of holding circuit for magnetic starter, circuit can be broken by depressing or bumping stopbutton very lightly, causing magnetic switch to open.

Prevent shutdowns by replacing short extension tube on stopbutton with a long one, so button is recessed in tube, sketch. Or use a snug-fitting removable cap over end of extension tube for more protection. On pushbutton stations that don't have extension tube around button, we ream hole with a taper reamer and fit a tube into hole.

On some switches a cap fitting over extension tube may be OK. Put cap on so stopbutton isn't depressed.

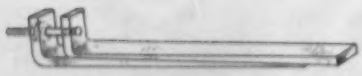
C TRETINYAK *Rochester, Minn.*

Suction plate for shallow tanks



SKETCH SHOWS suction plate made to pick up water from shallow pools inside gasoline-storage tanks when they are cleaned. It's made of a flange-to-bushing pipe reducer, with a strainer screen held by three bolts—the legs. Get suction as low as you can without taking air by grinding bolt heads to ¼ in.

O LE BRAGE *Oroville, Wash.*



Shim levels machinery

SKETCH SHOWS adjustable shim for aligning small machines. You can make it in different sizes to suit. Made of ¼x½-in. stock and cut with a 10-degree taper, stud-and-nut is on bent ends. After unit is adjusted to right height, the ¼-in. stud may be cut off, making a neat-looking job. This type of adjustable shim is handy when there's little room between machine and foundation.

H GREINER *Anoka, Minn.*

Did you know . . .

that the National Association of Power Engineers, 176 W Adams St, Chicago 3, Ill., has compiled a "Proposed Model License Law for Stationary Engineers?" If your state, city or town is working on such a law, you might help them by submitting this proposed model law.

Here's what I'd do for GPP's February headache

I CAN SYMPATHIZE with G P Pearce because of his propane problem, Feb, p 135.

Here, we too meet some freezing problems and handle them two ways: (1) We bury tanks to permit latent heat of earth to liberate gas. (2) We also use vendor's cylinders and chain them in manifold shed, where they're protected from atmosphere. We bring temperatures up with infrared lamps, which are controlled by both thermostats and magnetic switches.

Other devices (in operations' room) are dial-type thermometers and pressure gages to keep supervision informed on status of cylinder contents. Normal lamp application for Dec, Jan, Feb is 500 watts. We use a single 250-watt lamp directed on each spare cylinder. Spare cylinders are held in reserve for coupling to manifold as needed.

P C ZIEMKE *Oak Ridge, Tenn.*

Need some good transformer advice?

AN ENGINEER was preparing to inspect a transformer. He pulled the hi-line disconnects and was about to climb on top of the transformer when he thought he'd better try the terminal with a piece of fuse wire. The wire flashed.

He had forgotten that the plant had a circuit to a motor-generator set used for charging a battery bank. When the power went off, the batteries fed back and the m-g charged the plant circuit. Thus he had high voltage on the transformer. Caution: Before working on a transformer, clear both the hi and lo and hook a ground wire on both.

F L GILLMOR *Albany, N. Y.*

Simplicity and Good Design Features in

POWERS

FLOWRITE VALVES

STURDY, PRACTICAL DESIGN
Strong, light weight precision cast alloy housing is corrosion resistant. Only 6 bolts saves maintenance time.

OVER 60 YEARS
of Temperature and Humidity Control.

Ball Check Lubricator with Silicone grease for temperatures 40° to 500° F.

(b98)

give close control and they last longer

❶ **Diaphragm** has a formed bead which provides increased sealing action with increasing control pressure. It has no bolt holes. Diaphragm lasts longer.

❷ **Piston plate assembly** has a free floating thrust plate which absorbs side thrust. Closely guided piston plate maintains valve stem in accurate alignment. High tensile strength steel spring is cadmium plated and completely enclosed.

❸ **Adjustment screw** is non-rising ball bearing type cadmium plated, easily accessible, easy to adjust.

❹ **Packing:** Deep packing space contains preformed lubricated packing readily accessible. Note lubricator.

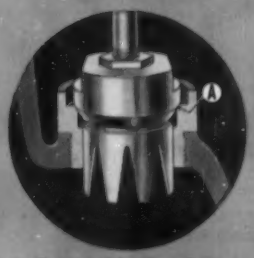
Accurate control results from smooth rolling diaphragm and minimum of valve stem friction.

Right type and size of valve is important for good control. An experienced Powers engineer will gladly help you make the right selection. Call our nearest office or write us direct.

For Pressures up to 250 PSI.

AT NO EXTRA COST
POWERS CONTROL SYSTEMS
Include these Premium Quality Valves

Get complete information, write for series 344 bulletins



Renewable Stainless Steel, Disc and Seat.

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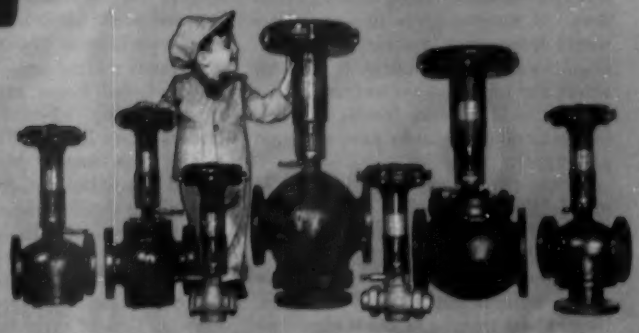
Available: Composition Disc also V-Port characterized which gives straight line control. Separate shut off seat (A) reduces wire drawing, insures tight shut off.



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More PRACTICAL IDEAS

Begins on page 134

Here's your 'trick' of the month

IN SEPTEMBER, p 127, R J Anderson tells about painting inside of hot-water tank. We had similar experience with fumes when painting 12 hot-water tanks last summer. I started blowing air into each tank with a vacuum cleaner.

That didn't work, so we put suction end of hose into far end of tank, away from manhole. It worked wonders. Not only did that draw all fumes out of tank, but it also drew in fresh air through manhole opening, thus giving good ventilation. Also, after being washed out, tank took only minutes to dry when using suction end of hose inside it. That saved more time.

When humidity is high, it's impossible to keep tank dry without good ventilation. We use a large vacuum cleaner, but a small one may work. Vacuum works in any closed vessel. We also use it for cleaning out boilers as men are more comfortable when fresh, cool air passes into the boiler. I've found they never become overheated, even if boiler is warm. Vacuum should work for drawing out fumes and pulling in fresh air before and while welding oil or empty gas tanks. When using vacuum for ventilating gas tanks or tanks with fumes, be sure to keep machine out and away from tank to prevent accidents. Don't forget safety.

J ARKOLA *St. Paul, Minn.*

What I'd do for GPP's Feb headache

PEARCE'S SOLUTION to falling butane pressures got results, solved problem. But heating bottled gas isn't always safe, Feb, p 135. Pressures can become dangerous. Cold may have resulted partly from gas expansion through reduction valves, chilling cylinders. If moisture was in gas, valves would freeze even quicker. When 75-degree water hit cylinders, it also hit valves and piping. They unfroze, allowing gas to flow more freely, and this higher pressure in tanks gave adequate gas supply.

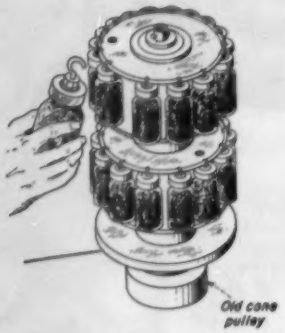
Better permanent setup would be manifolding more cylinders. Enough volume from all cylinders allows gas withdrawal at rate that latent heat and expansion of gas pressure will have within natural capacity of cylinders. Rate of heat transfer to gas is about two Btu per square foot of wetted surface per degree temperature difference. Latent heat of vaporization is 164 Btu for liquid temperature of 35 degrees.

Allowable rate of gas withdrawal varies so much with type of load, temperatures and humidity that handbooks from supplier or gas firm are a must.

Gas drier to remove moisture may help at low temperatures. Adding some propane would allow higher withdrawal rate, especially at lower temperatures. Sometimes adding small percentage of wood alcohol keeps expansion valves from freezing. Two-stage reduction freezes valves less; gas supply is more stable; also, smaller pipelines are required to point of use.

Radiator shouldn't be needed for normal temperatures. In hot weather it could result in dangerous pressures. Ventilate brick building exceptionally well to meet code for low-pressure gas storage. Cost of extra tanks and manifolding soon pays for itself, also gives more stable gas supply.

J H GRAHAM *Seattle, Wash.*



Glass jars + cable spool = lazy susan

SCREW-TOP GLASS JARS make useful containers for small parts. There are many ways to use them. One is to attach lid to under side of a shelf with a wooden screw. Then attach jar by screwing it into the cover.

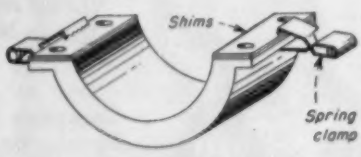
We found way shown in sketch the handiest. Lazy susan is made from empty cable spools. Punch a small hole in center of jar cover, insert a hook, using washers and nuts. Hook allows you to keep cover on jar at job or bench. You can also hang from a hook or a nail anywhere, making jar handy.

C H WILLEY *Penacook, N. H.*

Reach rod for valves

FOR THOSE SMALL VALVES just out of reach, make a handy reach-rod by welding head of carriage bolt to one end of a short ¾-in. conduit. Then bolt on an old valve handwheel. Flatten other end after inserting U-part of a doubled piece of 3/16-in. welding rod. Allow ends to extend about 2 in. out of tube.

H HOLCOMBE *Los Alamos, N. M.*



Spring-clip holds shims

IN REMOVING lower bearing caps on our diesel engines, we sometimes lose shims and have to fish them out of the crankcase. We tried using spring clips to hold shims in place so they wouldn't fall out. That solved our problem quickly.

M L MONSON *Fosston, Minn.*

what are good little Yarway Impulse Steam Traps made of?

STAINLESS STEEL, *of course*

Body and all internal parts of YARWAY Impulse Steam Traps are of *stainless steel*—one of the biggest steps taken by any trap manufacturer to increase trap life and reduce maintenance.

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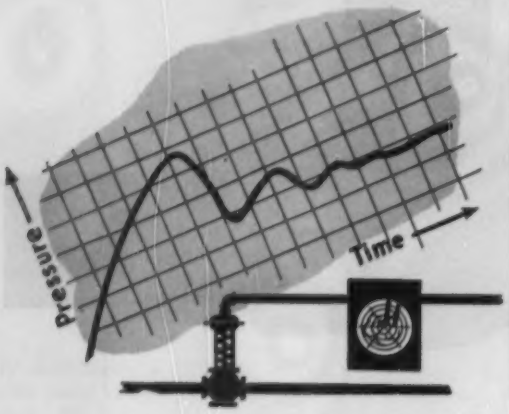
impulse steam trap

These PLANT PROBLEMS solved by



The question

How can we hold steam pressure constant?

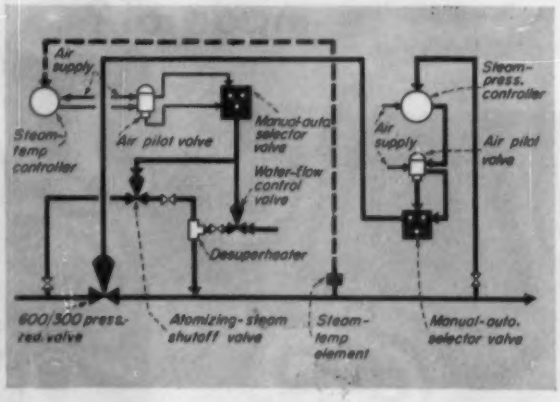
THE FACTS: New process in our chemical plant needs 300-psig steam. Its nature is such that steam load can vary between 5000 and 10,000 lb per hr. Load swings are rapid and the process can tolerate little deviation from 300 psig. Automatic controls include a steam-pressure-responsive proportional controller that sends an air signal to the 600/300-psig reducing valve in the process-steam supply line.

Our chemical engineers complain that steam pressure strays outside acceptable limits when load jumps or drops off suddenly because of a process change.

I've heard about control systems that are supposed to solve problems of this type—with automatic compensating features, but am not sure this is the answer. Would a positioner on the reducing valve help? How would we hook up such a system?

—AW, March Power

The answers



Right hookup for stable control

PRESSURE-REDUCING and desuperheating control system above should stabilize steam pressure and temperature within the limits *AW's* process requires. Selector valve on the pressure-control loop allows downstream-pressure regulation by adjusting the setting of the air-pilot valve. Adjustment may be automatic or manual.

Most hookups are furnished with reset and setback provisions. These features help keep steam pressure and temperature at their set points regardless of load changes and process time lags.

Positioner isn't needed on the reducing valve if the valve spring and diaphragm air pressure are correctly picked for actual flow conditions. If conditions, for which valve was originally selected, no longer exist, *AW* may be able to change the valve spring and control-air pressure range. I suggest he discuss this with the control-valve manufacturer.

Nearly constant boiler load is best for operating economy and minimum maintenance. But flow conditions require a sudden load change. It would be smart to investigate economics of a steam accumulator that allows boilers to operate at nearly constant load.

H B WAYNE *Brooklyn, N. Y.*

Check valve size, boiler conditions

FOR THE SUDDEN DEMAND SURGES of this system, present reducing valve may be either too small or too big. If the valve is too big, valve lift needed to pass steam at low demand points is extremely small and will probably cause the valve to cycle between partly open and full closed.

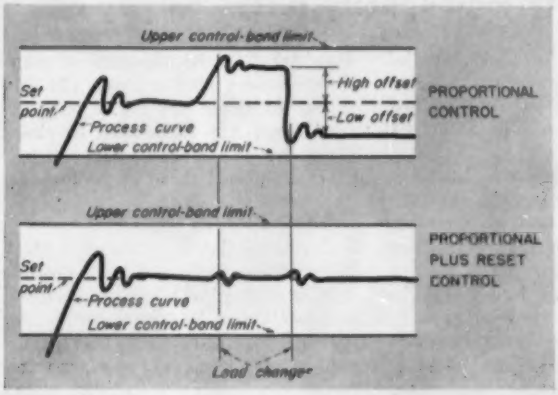
If steam demand varies over a wide range, it's possible to use a large and a small reducing valve in parallel. But good practice calls for a valve smaller than the pipe size, chosen on the basis of the allowable steam velocity and pressure drop across the valve.

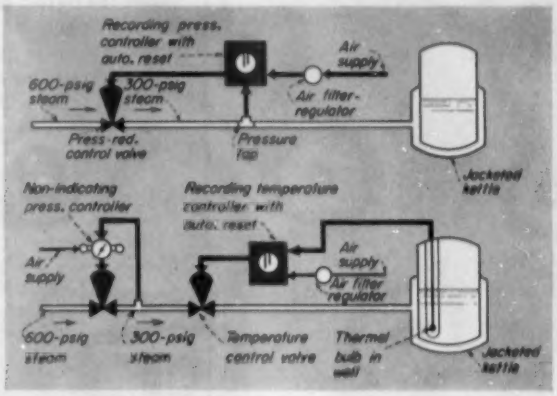
Boiler. Is the boiler room responding to demand fluctuations fast enough? If *AW* is using a hand- or semi-automatic-fired boiler, he should consider fully automatic boiler controls, or some form of signal system from process department to boiler room, warning of impending load changes.

P D HOBSON *State College, Pa.*

our readers may be your problems too

HOWARD KALLEN, *Assistant Editor*





Apply proportional plus reset-action controls to process

IN APPLYING an instrument circuit, consisting of sensing element, controller and valve, to a new or existing process, we try to match *process time lags* (due to heat transfer, thermal capacity, etc) to equivalent *lags* in the instrument itself.

Here's info *AW* should have:

Proportional response—gives a control-valve movement proportional to recorder-pen movement away from the set point. Thus, a 2-degree offset of the pen from set point yields twice as much valve movement as a one-degree offset.

Automatic reset—eliminates high or low offset shown in the first process-reaction curve above. It detects any change between pen position and controller set point; applies continuous corrective action to the control valve, pulling recorder pen back to the set point. Also, speed at which valve position is corrected is proportional to the offset. The greater this offset, the faster reset action strokes the valve back to its set point. This action *resets* the valve.

Automatic reset is always superimposed on a proportional-control instrument since reset's main job is to repeat the corrective action already determined by proportional controls. Frequency of repeats are in direct proportion to the offset.

Assuming *AW's* new chemical process consists of a steam-jacketed kettle, here are two possible solutions:

(1) A steam-pressure controller with automatic reset and proportional control.

(2) A simple pressure controller atop the 600/300-psig reducing valve's diaphragm. Also, a temperature control valve, downstream of the reducing valve, is actuated by a temperature controller with automatic reset. Arrangements (1) and (2) are shown above, right.

Solution (2) is the one I recommend since chemical process demands are, naturally, in terms of heat quantities. With a constant upstream pressure the temperature controller can throttle steam flow to suit the process.

With a 100% variation in heat load, from 5000 to 10,000 lb per hr, *AW* needs a reset controller. The load swings are rapid now because the proportional controller has a tendency to hunt or oscillate with process demand changes.

The boiler produces a fairly constant steam pressure. So it's easy to install a proportional controller on the 600/300-psig reducing valve. Then we proceed to control the really important variable—temperature. Temperature is probably the real culprit here because there's a big time lag through the steam-jacketed wall of the process vessel.

With *AW's* present system, steam pressure and temperature, supplied to the process, probably react to load changes as shown in first curve, above left. If automatic reset is added to the instrument circuit, offsets are eliminated, second curve. Note that only a small jog occurs in lower curve when the load changes—provided, of course, the instrument is set for the right amount of proportional as well as automatic-reset control. Manufacturer can advise on this point.

Does AW need a positioner? A valve positioner only makes sure that the valve stem is in the position called for by the controller. It will not reposition the valve at a new point, to correct for process load changes.

R SKROKOV, *Field Engineer*
Taylor Instrument Companies, New York, N. Y.

Readers give advice on high-IC fuses, p 142

Steam accumulator will handle *AW's* fluctuating loads

IF REDUCED STEAM PRESSURE is used in a process that calls for rapid load swings, a steam accumulator can supply steam during high-demand periods.

The accumulator is simply a storage vessel, floating on the process-steam line, that's partly filled with saturated condensate. When process load increases, steam pressure falls off. Resulting flash steam from the accumulator helps feed process demand, smooths out boiler load.

During low-demand periods the accumulator stores steam by condensing it. Thus, boilers can operate at nearly constant output, equal to average steam demand.

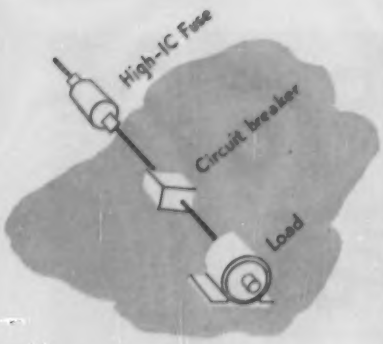
For best operation, the accumulator itself should be fitted with pressure controls.

H LEMELSON, *East Orange, N. J.*

(*More steam-pressure answers on p 212*)

Another PLANT PROBLEM solved by readers

Begins on page 140



The question

Will high-IC fuses back up breakers?

THE FACTS: We're facing up to a dangerous electrical condition because our available short-circuit current has outstepped our circuit-breaker ratings. In brief, incoming feeders are 13.2 kv, trimmed down to 2300 v for plant distribution. Total load is about 7000 kva. The local utility can now supply far and above the original available short-circuit kva over any of the feeders to our plant. This means that our present circuit breakers couldn't safely interrupt a solid short circuit if one occurred.

Since we can't sell top management on a new switchgear installation, can we safely use the high-interrupting-capacity type fuse to back up existing circuit breakers? Or, can we get replacement circuit-breaker units without buying completely new switchgear?

—SJ, March Power

The answers

High-rupturing-capacity fuses can pay off

ASSUMING that 7000 kva is the installed transformer capacity, worst asymmetrical fault condition on the secondary side of the transformer is about 185,000 kva.

Since *SJ's* plant probably has more than one transformer from 13.2 to lower voltages, maximum fault currents are limited to less than the value given above.

Secondary (2300-v) feeders can be backed up by high-rupturing capacity fuses ahead of existing breakers. Short-circuit trips on breakers can be set to insure fuse blowing before the breaker can operate. These fuses, depending on type and manufacturer, can interrupt up to 60,000-rms amp at 2.4 kv, equivalent to 150,000 kva. Equivalent ratings at 13.2 kv are 50,000 amp and 500,000 kva.

In evaluating economics of putting fuses ahead of existing breakers for short-circuit protection, consider these drawbacks: (1) No automatic means to restore service after a blow. (2) Possibility of single phasing if only one fuse blows. (3) Fuses must be closed manually. (4) A load-break switch is generally placed ahead of the fuses for disconnecting.

Detailed study of *SJ's* 2300-v system, including number and sizes of 13.2/2.3-kv transformations, will point the way to most economical selection of number and location of load-break switch and high-interrupting-capacity fuse combinations. A minimum of one per transformer can help protect against higher faults imposed on the system by boosted capacity on the utility's 13.2-kv distribution system. Such combination protective devices are less expensive than their equivalent-rated circuit breakers.

H C BAUMAN
Chemical Construction Corp
New York, N. Y.

SJ's best bet: Modernize NOW

INADEQUATE 2300-v circuit breakers in *SJ's* power system probably can't be replaced without buying new switchgear for the installation.

In general, breaker size increases with interrupting rating at a given voltage. Even new 2300-v switchgear may not solve *SJ's* problem since standard interrupting ratings at that voltage are limited to 150,000 kva maximum. With a 7000-kva load, short-circuit duty may already be near this figure. For a safe, adequate system, modernizing is the answer.

A possible system reconnection or distribution at a higher voltage is what *SJ* really needs.

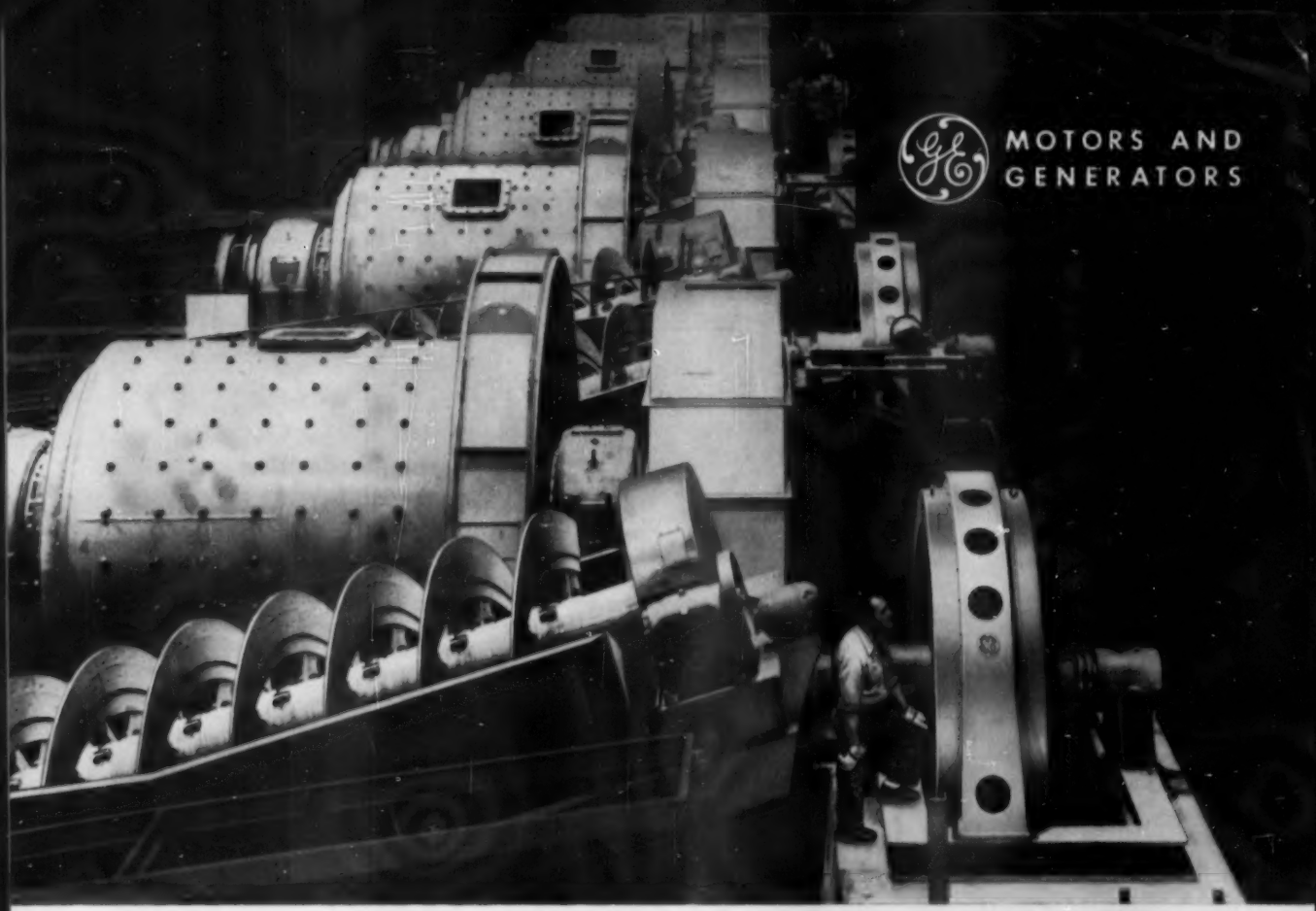
Fuses ahead of inadequate circuit breakers are seldom a sure answer to the problem since they have to meet these requirements: (1) Fuses must interrupt a maximum fault that takes place after the circuit breakers. (2) Normal operation must be restored, after removing or disconnecting the fault cause, by replacing fuses that interrupted the maximum fault, and reclosing the circuit breaker. While fuses may interrupt the maximum fault, there is no sure way of knowing, without tests, that a circuit breaker in the short-circuit current path won't be damaged.

Quite a bit of energy can pass through a power fuse—even a current-limiting fuse—before it melts and interrupts the circuit during a maximum fault. This is true even when current interrupts in less than half a cycle. Big mechanical forces that go along with peak, short-duration currents can damage circuit breaker.

If *AW* isn't sure that the high-interrupting-capacity fuses, he is considering, protect the circuit breakers while a short is being cleared, then fuses are money wasted. Safest thing to do—and probably the most economical in the long run—is to modernize now.

W C HUENING, JR.
Power Systems Engineer
General Electric Company
Schenectady, N. Y.

New questions, also more on high-IC fuses, p 144



SMOOTHING OUT A 1750-TON SMASH UP . . .

Specially designed G-E motors will power these record-size ore grinders

To grind tremendous volumes of raw copper ore for processing, the White Pine Copper Company recently put in service the six huge ball mills shown above. They are among the biggest in the world, capable of grinding to a fine mesh more than 1750 tons of ore per day; when they were planned there wasn't a motor designed suitable for driving them. Here is what was required: the drives would have to be of the slow-speed synchronous type, brawny enough to start the 300-ton mills from a standstill, smooth enough to cause only a minimum fluctuation of the supply voltage. White Pine Copper Company brought their problem to General Electric.

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TO G-E ENGINEERS, every big motor and generator job stands apart. Each has its own special requirements, and gets its own unique solution. But all jobs have this in common: they benefit from the research, engineering and manufacturing skills which so effectively solved the White Pine Copper Company's problem.

FOR COMPLETE INFORMATION on large motors and generators contact your nearest G-E Apparatus Sales Office. General Electric Co., Schenectady 5, N. Y.

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GENERAL ELECTRIC

More PLANT PROBLEMS

Begins on page 140

Fuses aren't substitute for circuit breakers

THERE ARE no substitutes for adequate circuit breakers in *SJ's* system.

High-interrupting-capacity fuses in series with old oil circuit breakers are better than the old breakers alone, but they have two limitations: (1) Fuses don't protect the under-rated circuit breaker from damage due to mechanical stresses caused by short-circuit current. These stresses are proportional to the peak short-circuit current permitted to flow through the fuse. (2) Fuses cause single phasing. So *SJ* runs the risk of burned-out motors.

Final answer also depends on (1) number and size of transformer banks (2) present switchgear and space available for modernization (3) how much can be spent on protective equipment.

J L FANNON *Electrical engineer*
Lockwood Greene Engineers, Inc
Boston, Mass.

Similar case in our plant

SOME TIME AGO we wanted to protect our circuit breakers against overstressing so we substituted a high-interrupting-capacity fuse for one disconnect.

We also worked out a relay scheme that kept the circuit breaker from opening for faults greater than its interrupting capacity. Fuses then interrupted the fault current.

For faults that the circuit breaker could safely interrupt, we used regular time-overcurrent relays to trip the breaker. This avoided nuisance-blowing of fuses.

H P BRUNCKE
Superintendent of protection
Northern States Power Company
Minneapolis, Minn.

High-IC fuse must blow within first ¼ cycle

HIGH - INTERRUPTING - CAPACITY current-limiting fuses have become popular in recent years on circuits rated at 600 v or less. They protect inadequate circuit breakers against fault currents greater than the breaker interrupting rating.

To get this protection, select fuse so it limits short-circuit current to a figure less than interrupting rating of the circuit breaker. To do this, fuse must blow within first quarter cycle after the short-circuit current is established—preventing current build-up that damages circuit breaker.

Magnetic forces, resulting from short-circuit currents, create stresses that damage a circuit breaker and can actually blow it up. But usually damage due to magnetic forces doesn't involve a safety hazard if fuse cuts off current in time.

There's no reason why circuit breakers operating on higher-voltage circuits can't be protected as well by high-interrupting-capacity fuses—*if* the fuse limits the fault current as well as interrupting it.

J C LEBENS *Bussmann Mfg Co*
Chief engineer *St. Louis, Mo.*

SJ should consider using reactors

A HIGH-IC FUSE may have the ability to interrupt large amounts of power, but to do any good, it should also have current-limiting ability. It should be able to cut off current before it reaches a maximum value—protecting the circuit breaker or other equipment in the circuit.

Answer to this problem looks more like the use of reactors than fuses.

M S CARLSON
Chief application engineer
I-T-E Circuit Breaker Company
Philadelphia, Pa.

Other readers sending good answers on high-IC fuses, for which we lacked space, are:

H B WAYNE *Brooklyn, N. Y.*
C G HOWARTER *Canton, Ill.*
C O VON DANNENBERG *Brooklyn, N. Y.*
L W FITZPATRICK *Jefferson City, Mo.*
A M DAMEROW *Elk River, Minn.*

YOUR JUNE PROBLEMS

1 Which air-conditioning system will suit our building best?

As engineer for a hospital that's about to go ahead with a building program, I'm faced with the problem of deciding between several proposals for air-conditioning the new building.

The new hospital will provide an additional 250 beds in a 6-floor building. We're in the Midwest where the highest recorded temperature is 110 F. Design dry-bulb temperature in common use is 95 F. Design wet-bulb temperature is 78 F.

Proposals generally divide themselves into two groups: (1) Fully centralized system; filters, air washer, fans and refrigeration machinery are centrally located. Ducts distribute conditioned air to hospital rooms. (2) Partially centralized system; refrigeration is handled centrally. Chilled water is distributed to several areas in the building, where coils handle actual cooling.

What are the relative merits of these two systems for a hospital of this size? How should our machine room be laid out?—*JM*

2 What is cause and cure for steam-turbine vibration?

In our industrial power plant we have a 5000-kw turbine-generator that's about seven years old. Since buying this machine we've opened it up twice, the last time about six months ago.

Turbine was OK until two weeks ago when an operator reported a vibration that's worrying us.

Naturally, we don't want to go through a complete overhaul now. But if the condition becomes more severe we feel that opening the casing may be the only answer. We don't want disk or bucket failures.

Do we need a complete balancing job? How will we do this? What's possible cause of trouble?—*AH*

Send your answers to Plant Problems Editor. Extra pay for photos, sketches.

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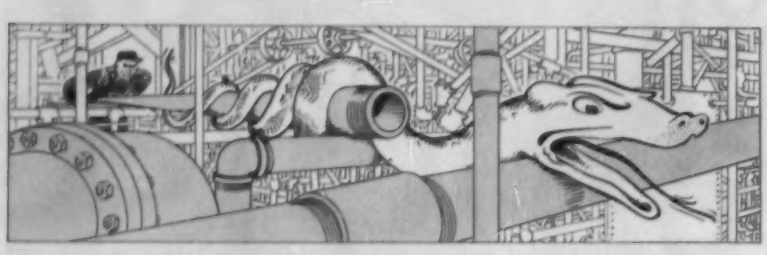
CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

ARGUMENTS . . . *pros and cons from readers' letters*

ALTHEA THORNTON, *Assistant Editor*



Snaky way to locate a pipeline route

BACK WHEN I WAS an apprentice, I worked under a character known as "Windy Jack," who had some qualities like Marmaduke's. Here's an example:

One day a small plant asked Windy to install a run of steam pipe during the week-end shutdown. He accepted on condition he would have the area to himself, and work with his own helper.

The pipe was to run through a maze of pipes, belts, shafts and pulleys. But Windy found a vacant space for a neat run of pipe, without any down loops.

On Monday the plant manager wanted to know how he did such a good job. Windy said, "It's all very simple. First I tie a live rat at the far end of the pipe. Then I tie a string to a gopher snake's tail and turn him loose at the other end. Pipe follows the string.

"A side-winder rattlesnake is better than a gopher snake, but the code of the California State Accident-Prevention Commission prohibits them."

H T LIVINGSTON

Los Angeles, Calif.

Three comments on AF's condemned boiler

Why did the inspector condemn a 250-hp cross-drum boiler when brick lining in the furnace center wall eroded? (Albert French's question in February Arguments).

According to his sketch, eroded brick was about midway up furnace wall. Since this brick supported the wall above it, the upper courses may have broken away on further erosion.

Sketch also indicates an underfeed stoker. With this type of firing, top of fuel bed is relatively high; combustion gas contacts furnace walls and tubes at nearly maximum gas temperature. Combustion gas usually contains compounds corrosive and erosive to refractories.

With highest gas temperature radiating from the fuel bed near furnace wall's midpoint, chances of ash-particle fusion and slag formation are greatest in this area. Firebrick erosion and eventual failure may result.

From data given, I believe shutting down the boiler until repairs could be made was the right thing to do.

H B WAYNE *Brooklyn, N. Y.*

Some years ago it was a practice to support watertube boilers on their own brick walls. Recently this type of support has been outlawed.

A common wall between a battery of two boilers was generally built with a 2-inch air space in the center, a core of common brick, and then a row or two of firebrick on each of the outer walls.

When these walls became so eroded as to eat through the firebrick protection, the fire made short work of the inner wall. With no support the engineer would be likely to find his boiler setting down on the stoker grate.

E H MCCATHRON

Bridgeport, Conn.

The story that Reader French tells is almost incredible. An eager-beaver engineer called in a boiler inspector and "had" him condemn an apparently serviceable boiler. The reason was a relatively minor amount of brick-work erosion, even though another inspector had approved the boiler only three weeks before.

Since when do boiler inspectors condemn or approve boilers at the request of the operator or owner? It is usually a serious business to condemn a boiler.

(*Continued on page* 216)

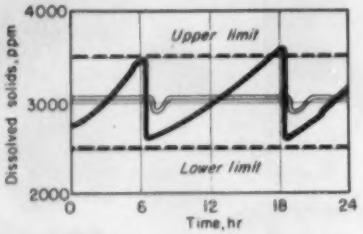
Best way to stop stack erosion?

ONE YEAR after going into service, our metal stack had corroded badly. We replaced it and cleaned inside and outside with a rust inhibitor, then painted all surfaces with an acid- and heat-resistant paint. Next, we covered outside with insulation and a galvanized jacket.

Apparently the insulation stops condensation of the acid-containing vapor that previously attacked the stack. By inspecting and touching up the paint each year, no corrosion has shown yet.

Because of the success of this installation, we have rebuilt stacks at two other plants in the same way.

DALE WEUM *Hopkins, Minn.*



Is this the way blowdown affects concentration?

CHART ABOVE, from article on boiler blowdown (September POWER), plots solids concentrations against time. But I don't think it shows what actually happens.

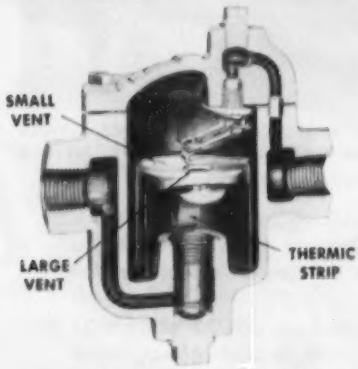
It indicates that, if a boiler is blown down, the concentration drops instantly from 3500 to about 2500 ppm. To accomplish this, you'd have to dump about one third of the water, then fill up at once with fresh water.

As I see it, the mere act of blowing down does not decrease concentration of dissolved salts. Water level is lowered without changing the concentration. Afterwards, boiler feed pumps speed up, feeding water faster than the evaporation rate. So concentration falls gradually. This continues until normal water level is reached, when water feeding rate slows down and concentration gradually increases.

Assuming that not more than 10% of the boiler water can be blown out at any one time, concentration of dissolved salts does not vary more than 10%.

W J RYAN *New York, N. Y.*

The Low Maintenance Trap for Low Pressure Heating . . .



Open Float and Thermostatic Trap

For fast heat-ups, Armstrong steam traps can be fitted with thermic buckets. These are excellent for heating systems that are shut off at night and turned on in the morning. Large opening in the bucket, controlled by a thermic strip, provides a fast discharge of air until steam enters the trap. Heat contracts the strip closing the opening. Non-condensibles that enter with the steam during normal operation are continually discharged through the small vent.

The Armstrong No. 800 trap above is operating at a 10 to 12 pound initial pressure and discharging into a return line carrying 5" of vacuum. In 12 year's service, maintenance costs on this and 99 other Armstrong traps has been practically zero . . . so reports Mr. Thomas B. Healy, Vice President of the Liquid Veneer Corporation.

The reason behind this low cost maintenance lies in the design, workmanship and materials used in the traps. The stainless and chrome steel internal mechanism is identical in design, workmanship and materials to the internal mechanisms of forged steel traps used for 900 lb. pressure and 900°F service. It is no wonder that these traps deliver such long, trouble-free performance operating under the moderate pressures, temperatures and loads of a low pressure vacuum return heating system.

Low maintenance is only one of the reasons Armstrongs are widely used for heating. There are others . . . uniform heating . . . faster heat-ups . . . easy cleaning and inspection . . . guaranteed satisfaction . . . competitively priced . . . backed by a nation wide sales and service organization. Ask your Armstrong Representative for complete details or write:

ARMSTRONG MACHINE WORKS
812 Maple Street, Three Rivers, Michigan

ASK FOR CATALOG J

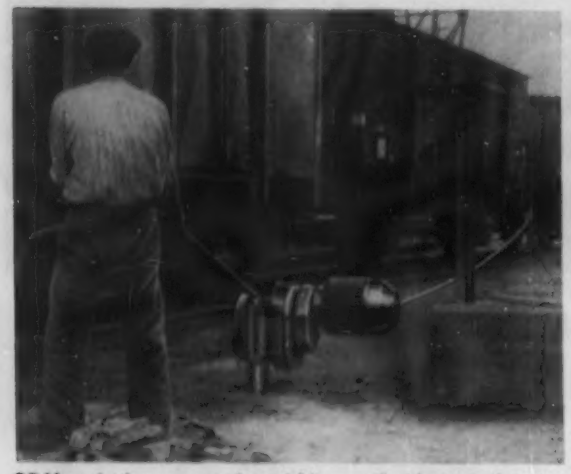
. . . . . contains complete installation and service information, physical data and prices for all Armstrong traps and accessories.

Application Engineered

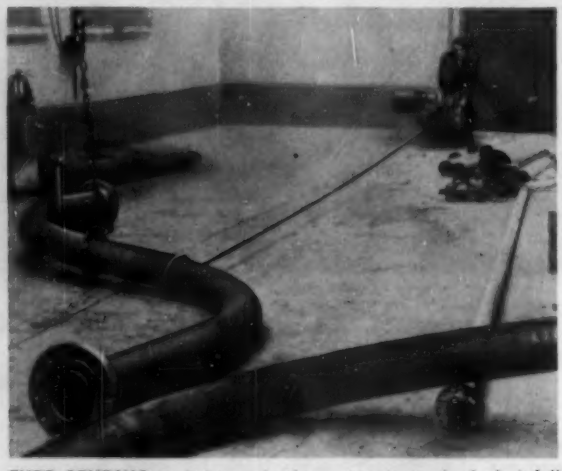
ARMSTRONG STEAM TRAPS

INGOTS are drawn from furnace by placing capstan as shown. Same capstan then moves ingot to work area where it's needed

LOGS are easily moved in sawmill yard by one man. Once they are placed where wanted, capstan is moved for next operation



COAL and other cars can be quickly moved without yard engine by one man. More than one foundation for same capstan is used



TUBE BENDING is light work if capstan instead of chainfall does bending. Here the chainfall is used only to lift pipe

HOW TO use mobile capstan

► HAVING A MOBILE CAPSTAN around your plant is like hiring a tame elephant to do your heavy pulling and hauling jobs. Unit comes in various sizes, is driven by electric motor. It also has place above motor for mounting internal-combustion engine if supplying electricity is a problem.

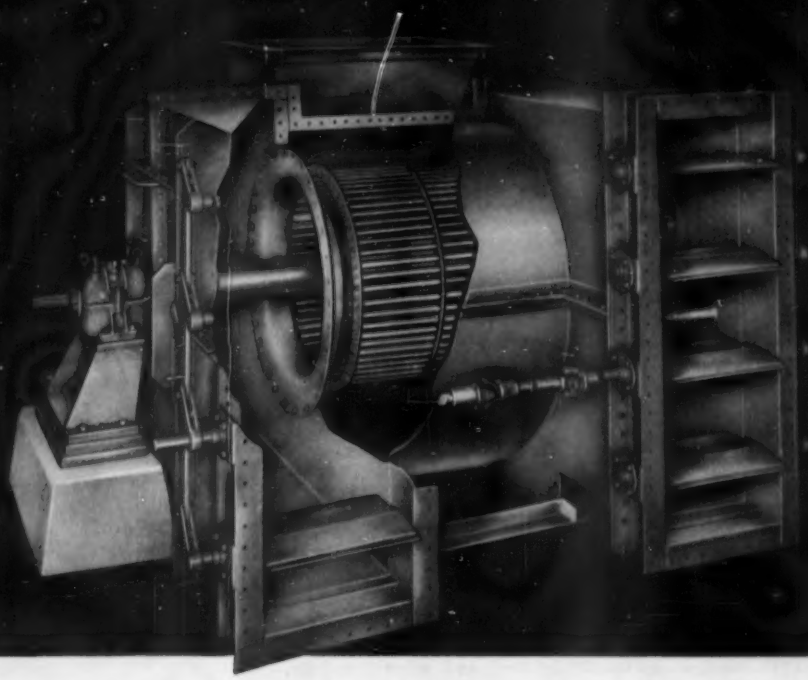
Pulley is offset in such a way that unit sets itself automatically in haulage direction. You can install various foundations in places where capstan is usually needed. Then move capstan to place you want it.

Speed reducer uses mass-produced parts to keep cost low. A stop prevents swinging over 350 degrees to prevent damaging electrical connections.

—Courtesy: ACEC Electric Corp, New York, N. Y.

Fact:

WESTINGHOUSE HEAVY DUTY INDUCED DRAFT FANS ARE ECONOMICAL . . . SAVE SPACE!



Inlet damper control saves horsepower at reduced loads by spinning entering gas in direction of wheel rotation.

The outstanding features of these Westinghouse-Sturtevant Heavy Duty Fans *with forwardly curved blading* offer the *best* combination, in public utilities and industrial plants, for both process steam and power generation.

1. **HIGH FAN EFFICIENCY**—Streamlined passages and improved blade proportions provide high fan efficiencies throughout normal operating range.
2. **LOW FIRST COST**—Less than any other conventional type for the same duty.
3. **SPACE SAVING**—Design permits handling large volumes of gas in relation to space occupied.
4. **LOW SPEEDS**—Operating speeds are lower than other conventional fan types.
5. **RUGGED**—Solidly built of welded reinforced steel plate and designed *specifically* for heavy duty induced draft service.

MORE FACTS? Call your nearest Westinghouse-Sturtevant specialist—he's the "Man with the Facts" on Mechanical Draft and other Air Handling applications, and Electronic Air Cleaning.

WESTINGHOUSE AIR HANDLING

YOU CAN BE SURE...IF IT'S

Westinghouse

J-80436

Westinghouse Electric Corp.
Sturtevant Division, Dept. 11E
Hyde Park, Boston 36, Mass.

Please send more facts on your Induced Draft Fans.

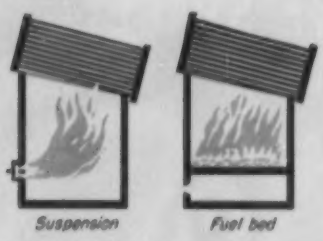
NAME AND TITLE .....

COMPANY .....

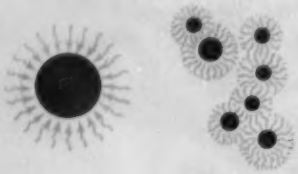
CITY ..... STATE .....

BASICS . . . *bringing engineering theory down to earth*

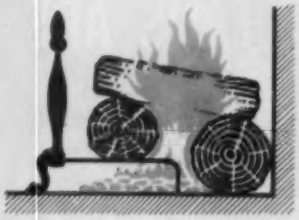
TOD WALDRON, *Assistant Editor*



1 Practical fuel burning takes two forms —suspension and fuel-bed firing



2 Small particles best for suspension firing—they show more area to heat



3 Heating and igniting fuel is mostly furnace's job. Here logs reflect heat

How fuels burn-6

► WE HAVE COVERED the fundamentals of burning in previous Basics. Now we're ready to tackle the job of combustion of commercial fuels in actual furnaces.

Let's see just what this job entails. Speaking in broad terms, it includes: (1) preparing the fuel and air (2) vaporizing or gasifying the fuel (3) bringing the fuel and air together in the right proportions and at the proper temperature for ignition and combustion, and (4) transferring heat from the products of combustion to the boiler or other surfaces while retaining enough heat in the combustion zone to maintain volatilization and ignition. All these actions are going on at the same time in any furnace. And each particle of fuel goes through all the steps, in order, during its brief passage through the furnace.

In general, burning takes place under two separate physical setups: the fuel burns (1) in suspension or (2) on a fuel bed (see Fig. 1). We will talk about both types of firing later so we can see how they differ and, more important, in what ways they are alike. This month we will start out with the first type.

Suspension firing. When we think of suspension, or burner firing, gas comes immediately to mind as the simplest example. Here fuel is already in the gaseous state, ripe for quick mixing with air. So all we need is to supply the right amount of air for the amount of fuel to be burned, and provide some means for mixing fuel and air thoroughly. How and when this mixing occurs depends on the actual burner design—difference in how and when mixing takes place, incidentally, is the primary difference between one burner and another.

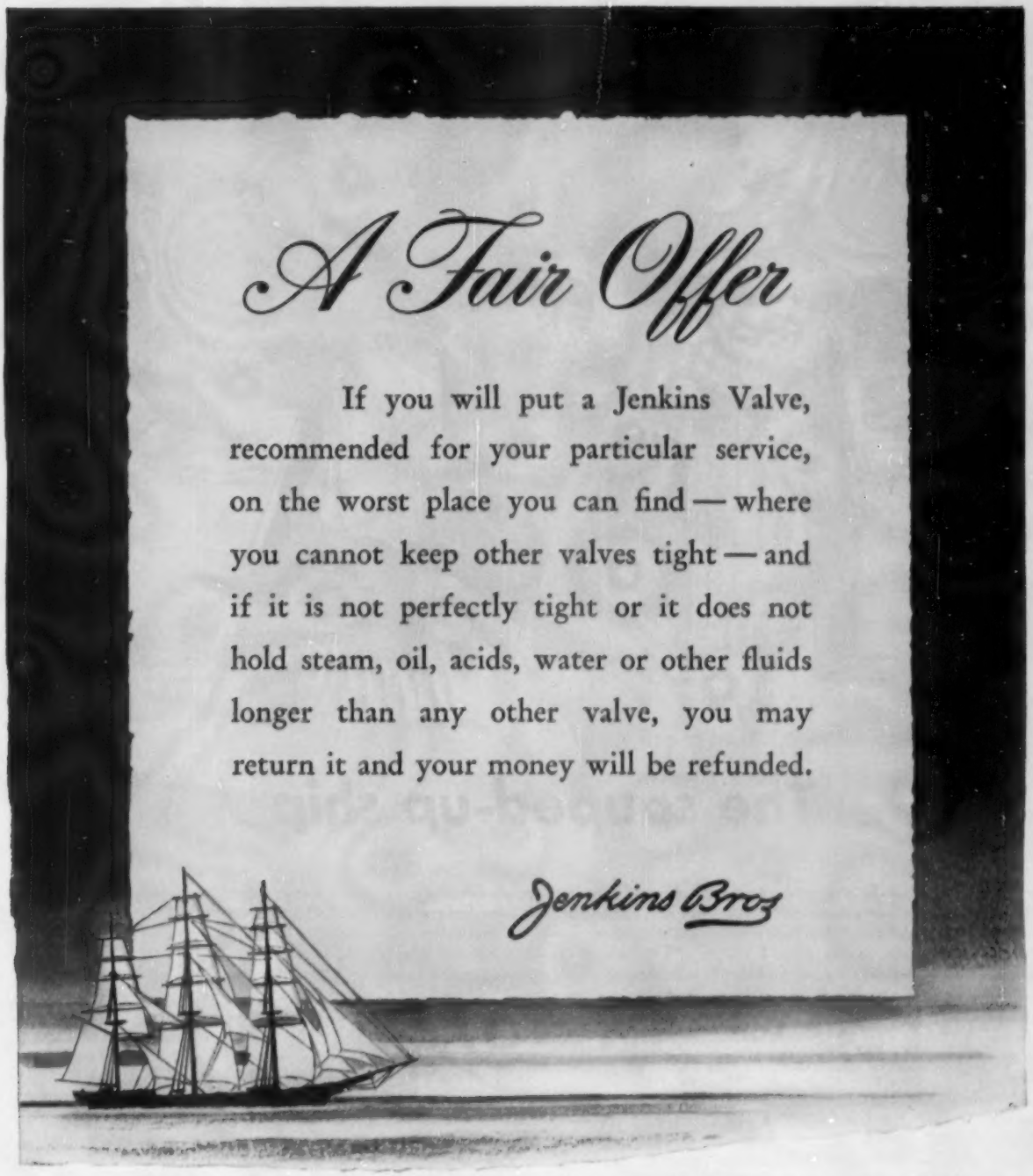
Burners for oil and coal, in addition to proportioning fuel and air, and mixing them, must also prepare the fuel. For oil, this means making it ready for conversion from liquid to gaseous hydrocarbons. For coal, it involves distilling off the volatile matter (gaseous hydrocarbons again, plus hydrogen and carbon monoxide). This must be done in the instant after the fuel enters the furnace.

Preparing fuel. It is the furnace heat that does the conversion—the job of the firing equipment is to put the fuel into a physical shape that makes the best use of this heat. For suspension firing of both oil and coal, the answer is the same—the fuel must be broken up into many small particles to expose as much surface to the heat as possible (see Fig. 2). With oil, atomization is obtained in a variety of ways by the burner; with coal, pulverization is handled in a separate unit, the burner merely mixing the finely ground particles with air and injecting the mixture into the furnace.

In addition to small particles, we need fast motion between the particles and air to strip away the microscopic "coats" of gas that form on the particles. This stripping exposes fresh surfaces to heat and air.

Furnace's job. The furnace takes over where the burner leaves off, providing the conditions for continuous complete combustion. Within the combustion zone, fuel must be vaporized or gasified, mixed with air, ignited, and the resulting reactions between fuel and oxygen carried to a finish. Chief responsibility for bringing fuel and air together rests with the burner. The furnace can do little to correct failure of the burner in this respect. On the other hand, heating and igniting are predominantly the furnace's job.

The difficulty met in trying to burn a single log in a fireplace illustrates the part played by good furnace design. As anyone who has tried will testify, a single log is one of the hardest things in the world to keep burning, while a number of logs will blaze merrily (see Fig. 3). The reason is that when there are several logs, each reflects heat to the others, for distillation of volatile matter and ignition. In the same way, a furnace must maintain a heat supply to prepare and ignite incoming fuel.


A Fair Offer
If you will put a Jenkins Valve, recommended for your particular service, on the worst place you can find — where you cannot keep other valves tight — and if it is not perfectly tight or it does not hold steam, oil, acids, water or other fluids longer than any other valve, you may return it and your money will be refunded.
Jenkins Bros

"A Fair Offer", first published in 1869, was more than a warranty of superior performance. It charted a course for fair dealing from which Jenkins Bros. has never veered.

By making valves that measure up to this forthright offer, Jenkins Bros. has continued to set the highest standards for quality.

"A Fair Offer" is republished, at regular intervals, as our pledge that those standards will always be observed.

JENKINS VALVES

LOOK FOR THE JENKINS DIAMOND

"I chopa up da guy who steala my minestrone — and I no fool thisa time."

The souped-up ship

► "Sure, the new fireman was good, all right. But he was scared stiff every time we took a bad roll," Joe Betz from Taunton, Mass. was saying when I visited the Bent Propeller Bar. "And the Second Assistant was tough and in the first place had no use for landlubbers on his watch. So he sent his oiler topside to the steward. In the galley, the oiler dumped salt mackerel into a bucket and stood by the fireroom ventilator up on the bridge. We were crossing the North Atlantic and taking over green waves, with heavy sprays going down into the fireroom. As soon as the next heavy roll sent the ship shuddering over on her beam end, the oiler heaved the fish and water down the ventilator.

"That was too much for the fireman, who wanted to be relieved every time the ship bounced around. So he lit out of the fireroom like a greased mackerel, yelling to the Second as he passed him in the engine room, 'I'm leaving. When fish start coming aboard I go topside—and I stay there.'"

That raised a commotion and everyone laughed—that is, everyone but Marmaduke Surfaceblow, Esq, the world-renowned consulting engineer. Marmy was leaning quietly on his end of the bar, silently nursing his bottle of drain cleaner, known in these parts as Sandpaper Gin.

About the time I got settled and my eyes could penetrate the tobacco smoke, I made out some of the other customers. There were seagoing characters, dry-land sailors and stationary engineers —also, some out-of-towners.

Now everyone seemed to be talking, laughing and drinking. Conversation was a hodgepodge about sea sickness, high-pressure boilers and the best way to beach-comb in a foreign port when you miss your ship. "Now take the *SS Tuscurora*," chimed in Sterling Krone, who was in town from Canby, Minn. and stood next to Marmy. "I shipped aboard her back in . . ."

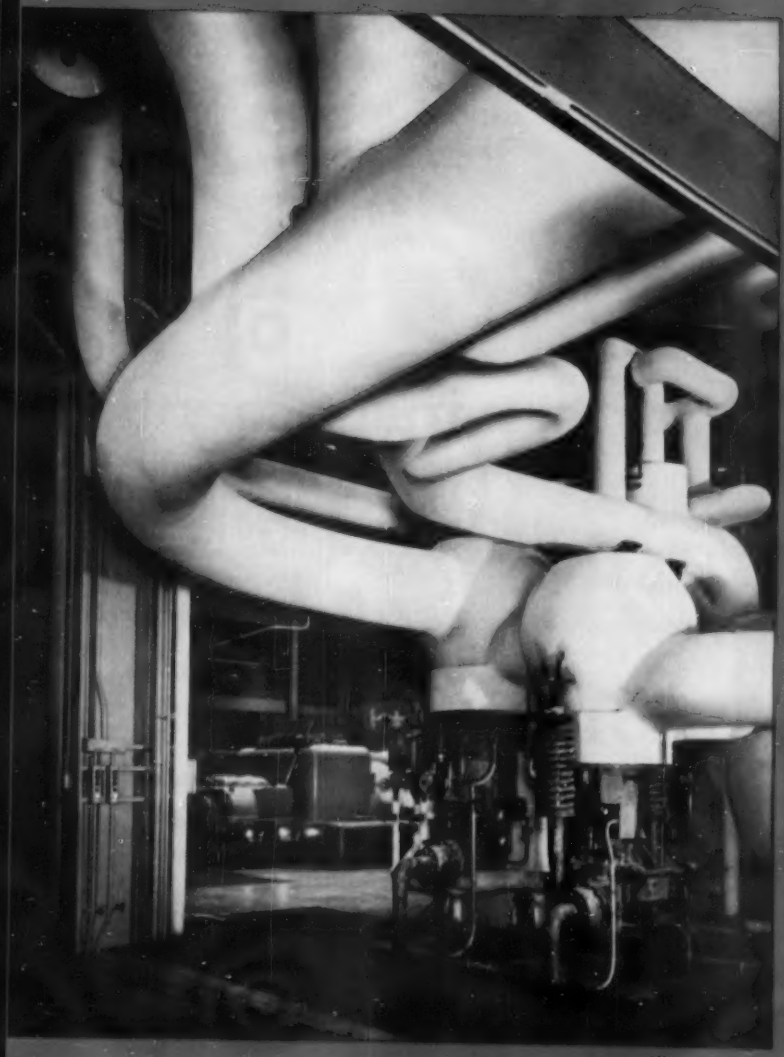
"Bilgewater on that old rust bucket," suddenly roared Marmy in his foghorn voice, slapping his empty bottle on the bar. "I'll tell you dry-land sailors about the time after World War I when I was First Assistant Engineer aboard the old *SS Grant* on her maiden voyage and how I got the bugs out of her system."

(*Continued on page* 202)

Marmaduke Surfaceblow, Esq

Batten down the hatches, man the bilge pumps, lash down the deck cargo! Here's Marmy, old marine, stationary and consulting engineer. Older Power readers know that this "uncolleged" engineer has been sounding off in Power since January 1948. He tackles tough plant problems in the most unengineering ways—but always seems to come up with a solution. His favorite hangout? The Bent Propeller Bar.

What do you buy when you place a *Piping Contract?*



What you really buy is performance . . . and good value for your piping dollar. And how do you get these? By selecting a piping contractor who has a reputation for quality work . . . who is called upon to do job-after-job for the same customers. It's as simple as that.

Midwest is such a piping contractor. Midwest Piping is superior piping and good value for every piping dollar. We shall be happy to have you ask us to prove it.

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MIDWEST **PIPING FABRICATION and CONSTRUCTION**

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MODERNIZING?

New equipment needs the right instrumentation

When you're planning to install new equipment, plan to take advantage of the full potential of modern methods of measurement and control. It's the sure way to get top value for your modernization investment . . . for the improvements in production economy, quality, and versatility possible with today's production equipment depend increasingly on control instrumentation.

Here are two important points that deserve consideration if you're planning to modernize:

1. Design for control. Instrumentation is more than a necessary appendage. It's a vital, integrated part of the process itself. *Control design goes hand in hand with process design.*

2. Get the right instrument for the job. This seems obvious—but all too often instruments may be stretched or squeezed to fit applications for which they were never intended. *Each instrument should fit its function.*

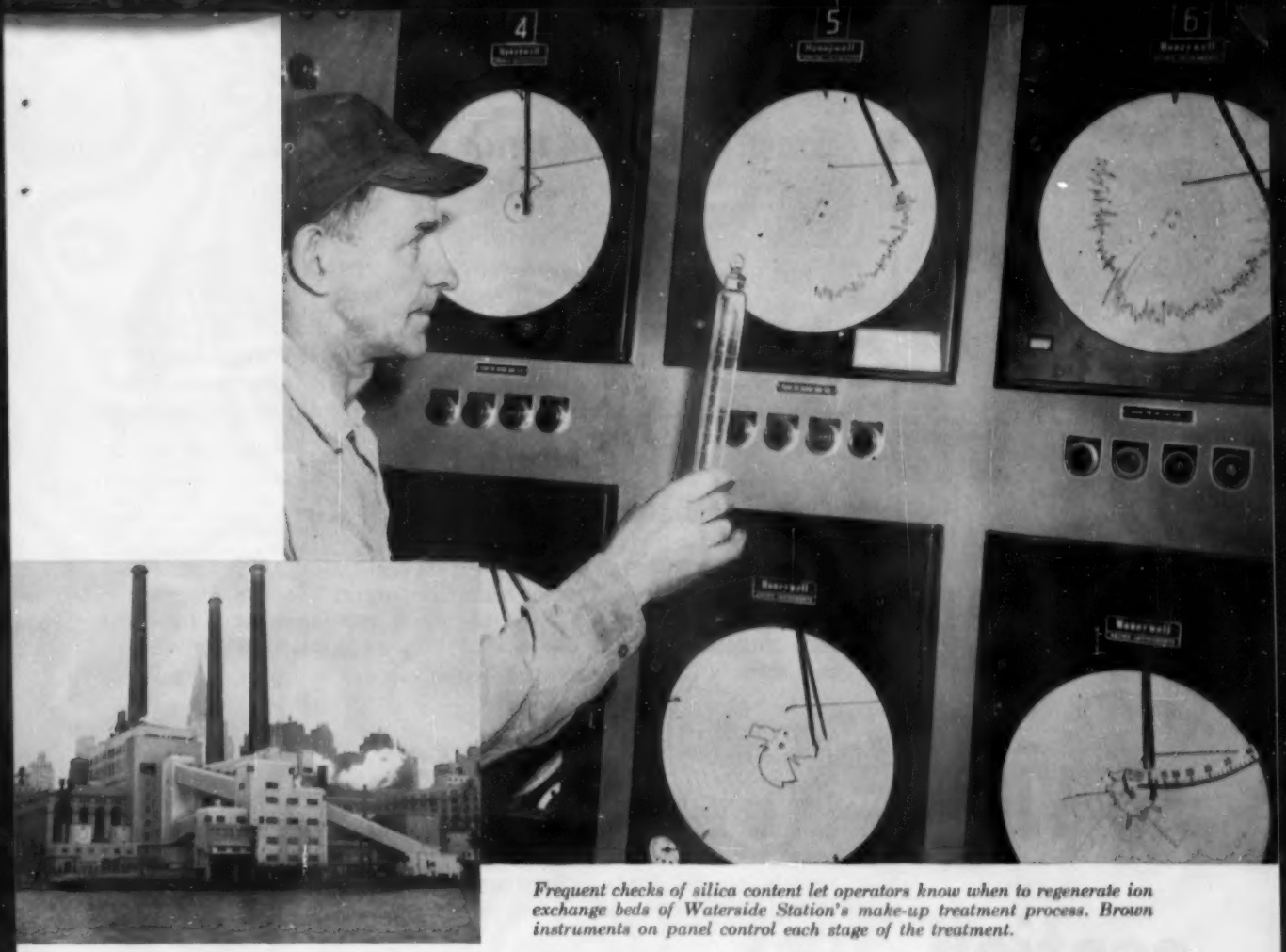
On point number 1, Honeywell's experienced application engineers will be glad to cooperate with your own staff to recommend ways in which you can obtain the full benefit of modern instrumentation. They have an extensive background not only in contact technology, but also in the processing problems of various industries.

On point number 2, Honeywell offers an exceptionally wide line from which to choose. You're sure to find instrumentation with exactly the right performance . . . at the right cost . . . to fit your process. You eliminate problems of "shopping around" . . . and divided responsibility. This one source can fill practically all your measurement and control requirements.

A talk with your nearby Honeywell sales engineer will give you a detailed picture of what instrumentation can mean in your modernization program. Call him today . . . he's as near as your phone.

Brown instruments help Con Edison station treat

View of part of the installation of six "Illco-Way" mixed-bed de-ionizers, which reduce silica content of raw make-up water by ion exchange...under control of Brown instruments.



Frequent checks of silica content let operators know when to regenerate ion exchange beds of Waterside Station's make-up treatment process. Brown instruments on panel control each stage of the treatment.

2 million pounds of make-up per hour

CONSOLIDATED EDISON'S Waterside station is a large, modern 100% high pressure station. And it had one of the biggest make-up water problems . . . for beside supplying its 658 megawatts of generating capacity, the station also feeds 200 psi steam to New York's skyscraper heating system. As much as 2½ million pounds of make-up per hour may be required.

To minimize scaling troubles due to silica content of the raw water, the station was recently equipped with "Illco-Way" ion exchange treatment equipment that de-ionizes this large volume of water in a continuous, completely controlled system. Designed and built by Illinois Water Treatment Co., the one-million-dollar system consists of six mixed-bed de-ionizers. The installation is equipped with an extensive complement of Brown instruments that measure and control critical variables.

Separate Brown integrating flow recorders check the flow of softened water to each of the six mixed beds. A multi-point *ElectroniK* conductivity recorder charts the purity of effluents, as a check on operation . . . and operates alarms when conductivity gets too high. pH of treated effluent is recorded by another *ElectroniK* instrument, which also warns when pH drops too low. Other Brown instruments measure and control reagents and rinse-water flows and temperature during the regeneration of the individual ion exchange beds.

The net result is that make-up water with silica content consistently below 0.02 ppm, and conductivity about 1 micromho, is fed to the station's boilers . . . with only a minimum of individual attention by plant operators.

For a discussion of how Brown instruments can go to work advantageously in your own plant, call your local Honeywell sales engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA:**
Write for Catalog 90-2, "Supervisory Instruments for Power Generation."

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

Reader service section

Start with these quick samples . . .

That coal-burning gas turbine . . .

is piling up operating hours again. With four rows of new blades and an improved flyash separator, tests were resumed in 1954. After over 700 hours on coal, much of it at high load, inspection revealed no measurable erosion or ash deposits. Reports from the Field is your source for the facts and figures. And . . .

On the light side . . .

the same section carries news of the first application of high-frequency fluorescent lamps. Forecast in our special report "Today's Electrical Practice" (Oct 1953), these 400-cycle lamps have moved out of the lab and into Union College's new field house. To see why this system promises new economy in high-bay areas, turn to . . . . . p 158

No time for "the papers"?

Then Technical Briefs is your dish. A few minutes with these columns give you the gist of the latest technical papers. Abstracted for busy power men this month are 17 reports on nuclear power, piping, pressure vessels, engines, feedwater treatment. And if the digest makes you want to read the full story, there's dope on how to get it. . . . . p 160

No one is complaining . . .

about this hard seat. Not when it's "Brinalloy," the new seating metal used in Lunkenheimer's LQ600 bronze valves. Hard all the way through, this material is said to resist wear and corrosion better than 500 Brinell stainless steel or 1000-Brinell casehardened stainless. For facts on these valves and other maintenance-cutting new products, take a quick run through Plant Equipment News. It begins on . . . . . p 164

Kickoff item . . .

In this month's Free Literature is New York Blower Co's 20-p bulletin on industrial fans. It heads a parade of over 50 useful pamphlets—any of which can be had for your files at the drop of a postcard. . . . . p 173

Pigs is Pigs . . .

or so we thought until we read George Edwards' Scrapbook and found out they could be an engineering problem. For the answer, see. . . . . p 176

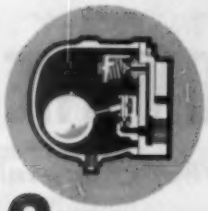
For other timely ideas, see following service pages ▶

1 Sarco Thermodynamic

Valve head, a solid stn. st. disc, is only moving part. Same head and seat to 600 psi. Withstands superheat, water-hammer, corrosive condensate. Cat. 255-A

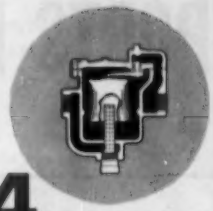
2 Sarco Balanced Pressure Thermostatic

Greatest capacity per dollar cost. Large air venting capacity. Same head and seat, 0-300 psi. Freeze-proof. Cat. 250-A



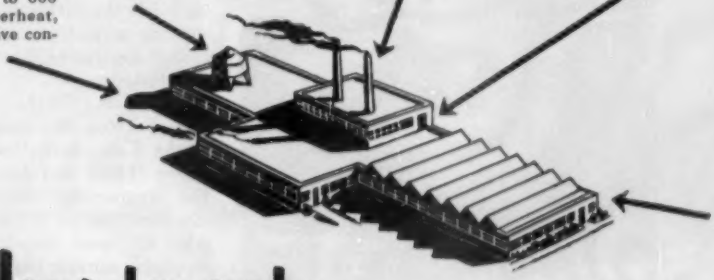
3 Sarco Float-Thermostatic

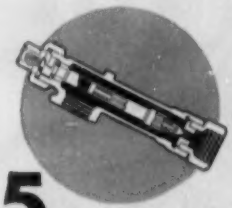
Discharges condensate continuously at steam temperature and without shock. Responds immediately to varying loads and pressures. Cat. 450-A



4 Sarco Camlift Bucket

New, powerful Camlift valve mechanism permits greater discharge with no increase in size of trap body. Cat. 360-A





5 Sarco Liquid Expansion

Adjustable to discharge condensate BELOW 212°F. Freeze-proof. Not affected by water-hammer or pressure pulsations. Cat. 260-A.

How to get efficient steam trapping ...throughout your plant

With these *5 Basically Different* Types of Sarco Steam Traps you can select the trap with the characteristics that match your *specific* job conditions.

Just because a steam trap discharges condensate and air and closes to steam doesn't necessarily mean it's doing a good job. For maximum efficiency, a trap must also keep conditions within the steam spaces right for the heat transfer job to be done.

For example: A Bucket Trap will work on a unit heater—but its discharge is intermittent. Between discharges, condensate collects in the small steam space of the heater causing undesirable changes in air temperature. The continuous discharge Float-Thermostatic Trap will, however, keep the heating surface free from condensate *all the time*—insure uniform air temperature.

That's why no one type of steam trap can give best trapping results under all job conditions. And that's exactly why Sarco makes 5 *basically different* types of steam traps—each with a different set of operating characteristics.

Solve Your Trapping Problems

And because Sarco makes all 5 types—not merely variations of one type—you can always get *impartial* advice from Sarco, based on over 43 years of field experience. Write to your local Sarco representative or to Sarco Company, Inc., Empire State Building, New York 1, N. Y.

ONLY SARCO makes all 5 types of steam traps

—not merely variations of one type! 2110B

REPORTS FROM THE FIELD

What's happening in power and what it means to you

For Calendar of Events see page 250

Conveyor belts carry coal nearly 3 miles to feed nation's largest power plant

► A NETWORK OF NEARLY three miles of rubber conveyor belts keeps coal flowing into the nation's largest electric power producing steam plant.

Coal hauled by the multiple belt-road supplies 14,000 tons of fuel a day for the ten 150,000-kw generating units at the Tennessee Valley Authority Shawnee plant, Chiles, Ky. Electric power produced at Shawnee is fed to the gaseous diffusion plant operated by the Atomic Energy Commission at Paducah, Ky. In partial operation since early 1953, the Shawnee plant will go into full operation late in 1955 when all of its generating units will be producing.

Manufactured and installed by the B F Goodrich Co, Industrial Products div, elevated sections of the belt speed overland on towers raised as high as 50 ft above ground. Belts go up steep grades, span a river channel and road, probe underground for short runs to reach a 1,450,000-ton stockpiling area. Coal tonnage carried daily by the system could produce the electrical power needed for a city the size of Detroit.

Operating in four directions at once, the belt system conveys coal to the plant from Ohio river barges, north of the plant, and from railroad coal cars, south of the plant. The belts can be directed to carry coal either straight to the plant for immediate use or to a stockpile for storage. The entire network is controlled by one man at an electronic control panel.

The complete conveyor system is composed of ten sections of rubber belting, ranging in length from 200 to 2640 ft, pulley to pulley distance. Belts are as wide as 54 in., handle to 1200 tons of coal an hour and move at speeds to 480 fpm. Three of the belts carry their loads up 16-degree inclines. Transfer points, located where two belts join, automatically cause the coal to discharge from one belt to the other.

To install the 14,746 ft of rubber conveyor belt used on the belt-road, rolls weighing as much as 20,000 lbs and measuring as long as 1765 ft were shipped to the plant site by rail. A total of 15 splices were made by a portable electric vulcanizer to make the belts into an endless chain.

Coal-burning gas turbine piles up operating hours

► OVER 700 HOURS of successful coal-burning gas turbine operation were logged in the current series of tests, according to a report presented at the annual meeting of Bituminous Coal Research, Inc.

Since Jan 1953 the coal-burning gas turbine has been a cooperative project of the Locomotive Development Committee (LDC) and Alco Products, Inc. The program for 1953-54 was divided into three parts: (1) to study and develop the most economical means for supplying suitable coal for turbine locomotives, (2) to design, build and install an improved fly ash separator, and (3) to install four new rows of blades in the LDC turbine and conduct tests to determine whether the new separator could prevent blade erosion.

Turbine re-blading was completed late in 1953. Blades were manufactured by Alco from 19-9-DL, a chromium-nickel alloy widely used for gas turbine disks and blades, but lower in high-temperature strength than the S-590 alloy originally used. The turbine was rerated to 3540 shaft hp at 80-F inlet temperature,

(*Continued on page* 242)

High-frequency lighting system uses 400-cycle power

► FIRST APPLICATION OF high-frequency fluorescent lamp operation for general lighting of a large area has been installed in Union College's Alumni Memorial Field House.

Designed and developed by General Electric Co, the system calls for opera-

(*Continued on page* 246)

THEY WANTED A SINGLE RESPONSIBILITY CONTRACT

The National Petro-Chemicals Corporation wanted a single responsibility contract for the construction of their plant at Tuscola, Illinois.

THEY CHOSE PRITCHARD

The master contract offered by Pritchard assumes full responsibility for engineering, design, drafting and construction. You benefit four ways: 1. You know the total cost before the job begins. 2. You have a firm guarantee of operation and efficiency of the completed plant. 3. You realize great savings from co-ordinated purchase of materials . . . reduction of labor costs . . . uniform control of construction. 4. You realize a faster return on your investment because of earlier completion date.

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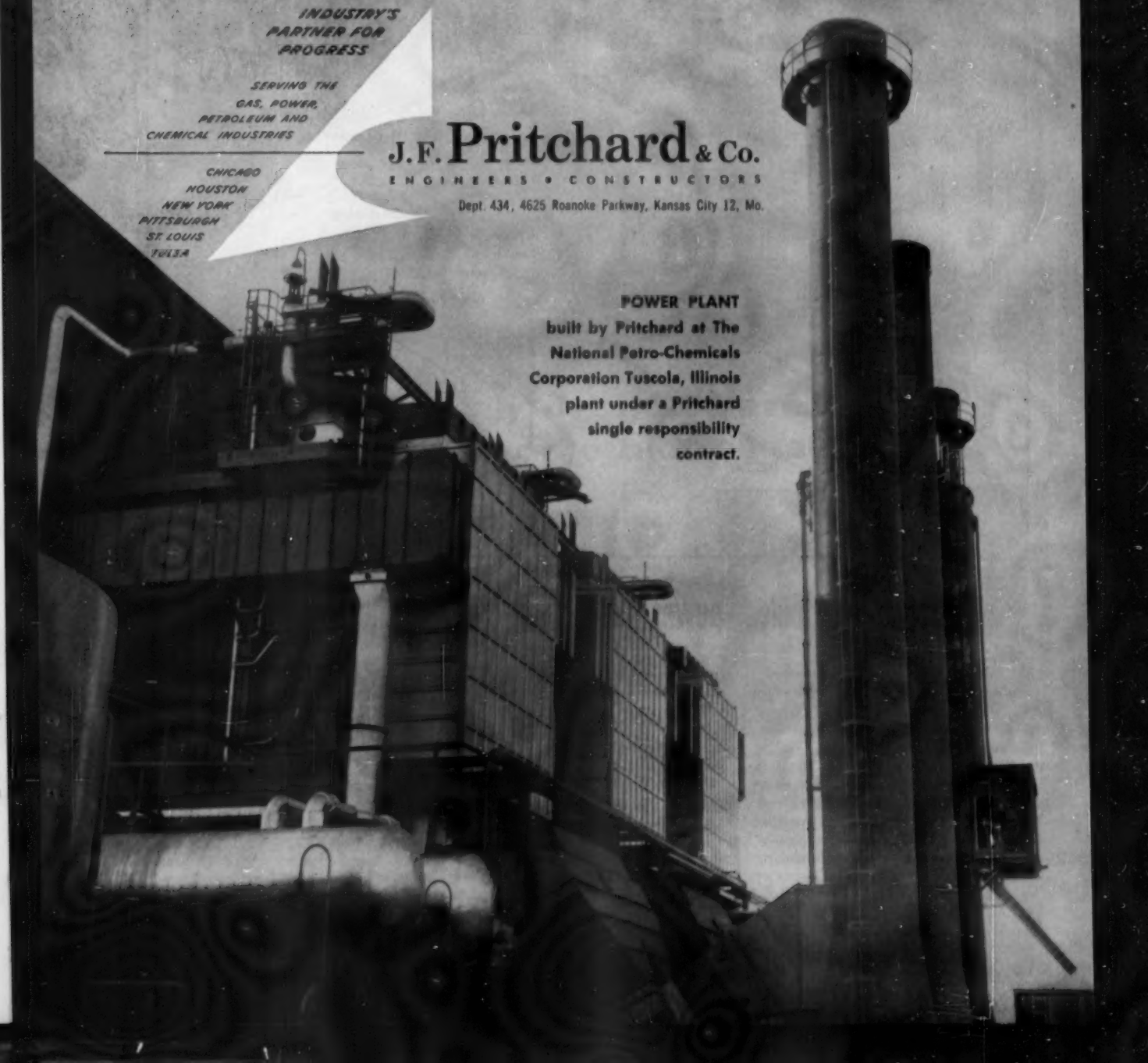

POWER PLANT built by Pritchard at The National Petro-Chemicals Corporation Tuscola, Illinois plant under a Pritchard single responsibility contract.

TECHNICAL BRIEFS

Latest engineering developments for busy power men

17 Digests for you on:
NUCLEAR POWER
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ENGINES
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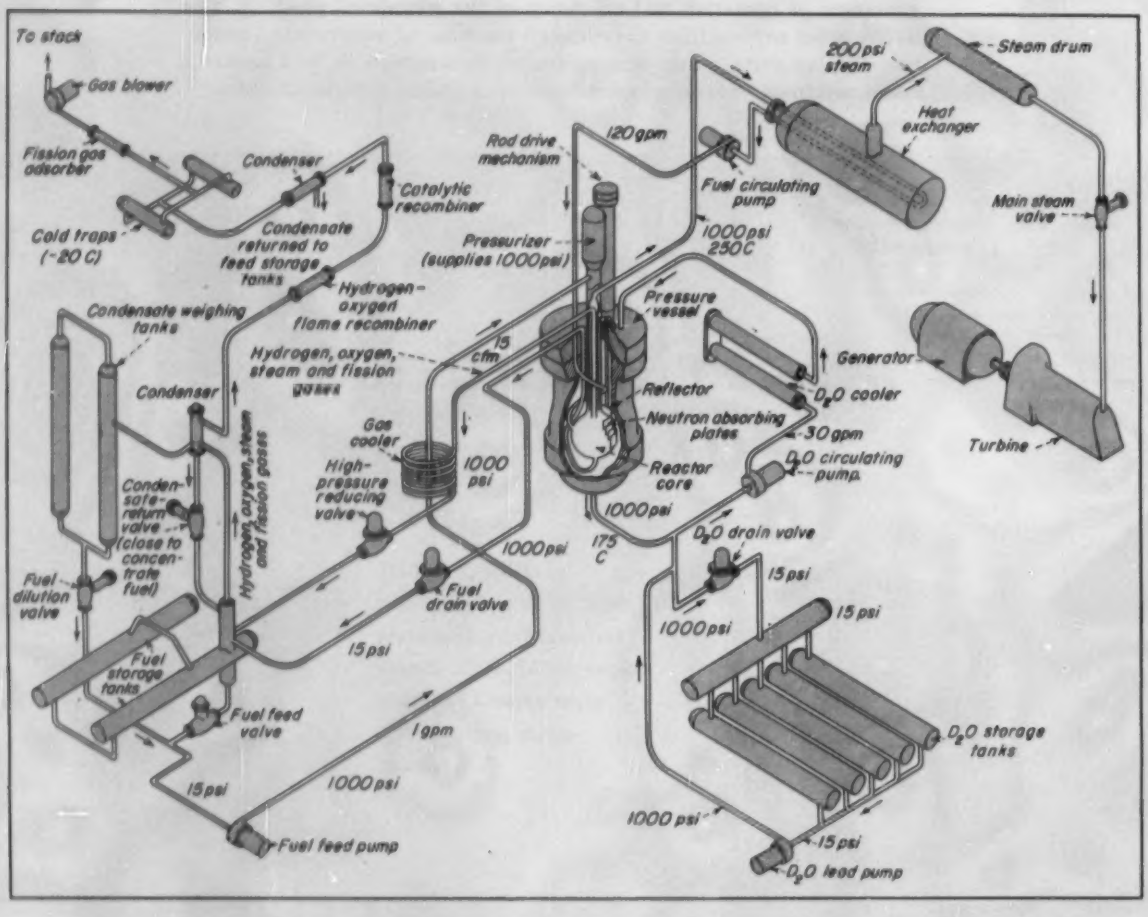


Pilot-model nuclear power plant using a homogeneous reactor

The homogeneous reactor experiment—a pilot-model nuclear power plant. *By W R Gall, Oak Ridge National Laboratory, Carbide and Carbon Chemicals Corporation.*

A nuclear pilot plant for production of electric power with an aqueous solution of uranyl sulphate as fuel has been designed, constructed and operated by the Oak Ridge National Laboratory over a four-year period. The heat-producing reaction occurred in an 18-in. diameter spherical vessel.

Heat was removed by pumping the liquid fuel through a U-tube heat exchanger where steam was generated for use in a small turbine, as shown above. With the reactor generating 1000 kw of heat at 482 F and 1000 psi, 3000 lb per hr of 200-psia steam was produced. This generated 150 kw of electricity.

Designs of major equipment items are described and cost of construction is summarized. It is interesting to note that installation of reactor equipment, piping and instrumentation is 36.5% of the total cost. Material costs for the same items total only 19.3%.

Though the entire reactor has now been dismantled so the building and auxiliary equipment may be used for more advanced pilot-plant experiments, the experience with this unit is both interesting and instructive. *ASME paper no. 55-S-15.*

Evaluating basic materials for nuclear-fueled power plants. *By D O Leeser, Nuclear Power Development Dept, The Detroit Edison Co.*

Reactors fueled with enriched uranium, or U-235, have been constructed and operated. However, converting concentrated heat potential of this fuel into superheated steam, that in turn pro-

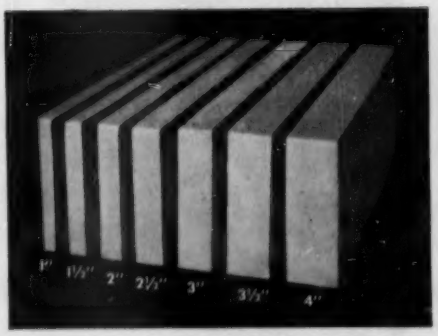
Specify J-M Superex, industry's favorite block insulation

Made from diatomaceous silica and asbestos for all temperatures to 1900F

YOU'LL ENJOY *greater insulation savings* with Superex®. Its unique combination of low conductivity and outstanding resistance to high temperatures provides greater operating efficiency and longer maintenance-free service. That's why Superex is the leading block insulation for furnace work.

Light and easy to work. Superex withstands temperatures to 1900F indefinitely with negligible loss of efficiency and is so strong that it compresses only ⅛ inch under 6 tons' pressure per square foot. Its light weight, excellent working properties and availability in large blocks mean quick, easy, low-cost installation.

For high temperature equipment. Since its introduction in 1927, Superex has received enthusiastic acceptance. Today it economically insulates 90% of the country's hot blast stoves. Other high temperature equipment where Superex has proved its superior performance include most types of industrial and metallurgical furnaces and ovens, stationary and marine boilers, regenerators, kilns, roasters, high-temperature mains, flues and stacks.



Saves waste—Superex comes in 7 standard thicknesses from 1" to 4". Other sizes available on order.

For further information on Superex, write to Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ont.

Johns-Manville *first-in* **INSULATION**

MATERIALS · ENGINEERING · APPLICATION

More TECHNICAL BRIEFS

Begins on page 160

duces power, requires a complex plant.

Included in requirements for the plant are primary and secondary cooling systems, specially designed heat exchangers, critical and accurate control mechanisms, and built-in remote-handling facilities.

Fortunately, there has not been any dearth of designs of nuclear reactors technically capable of producing electrical power. The problem has become one of balancing economic aspects with technical and design specifications. *ASME paper no. 55-S-14.*

Selection of materials for a sodium graphite reactor system. *By C C Woolsey, Jr, North American Aviation, Inc.*

The sodium-cooled graphite-moderated nuclear-reactor system has been included as one of five approaches to economic nuclear power being sponsored by AEC. The program calls for construction and operation of an experimental reactor with no power-generating plant. Heat is to be exhausted to the atmosphere through sodium-to-air heat exchangers.

The reactor will generate about 20,000 kw of heat at temperatures near 1000 F. Advantage of this system is that such temperatures can be obtained at normal atmospheric pressures.

Criteria are discussed for selection of materials for components of the reactor. Discussion is limited to those materials in contact with the sodium coolant up to temperatures as high as 1200 F, both in high radiation field existing within the reactor core, and in piping and heat exchangers external to the core.

Materials involved are zirconium and stainless steels. Selection criteria include usual high-temperature considerations of strength and compatibility with other materials in the system, and also their parasitic neutron absorption. *ASME paper no. 55-S-16.*

Shielding concepts for nuclear reactors. *By H E Stone, General Electric Co, Knolls Atomic Power Laboratory.*

Nuclear power plants produce large quantities of heat accompanied by highly dangerous radiation. While it is important to harvest heat and control the reactor, it is also necessary to protect personnel from radiation. This paper deals with sources, general shielding concepts, shielding materials and types of shields for various applications.

The shield must be designed to reduce all reactor and shield radiation sources to acceptable tolerances. Radiation of different types, neutrons and gammas, can be added in their effect and the sum of individual doses must not exceed the AEC tolerance of 0.3 rem per week. All major sources of radiation in reactor shields are discussed in the paper.

Three types of shields are mentioned: (1) unit shield for land-based reactors where weight and space are not of prime importance, (2) compartment shield for mobile reactors where a radioactive coolant and heat-transfer equipment are in a shielded area to reduce total shield weight and size, and (3) divided shield, which is the lightest of the three, but allows a large unshielded area between the reactor and personnel compartment. *ASME paper no. 55-S-20.*

The use of benzene as a thermodynamic working fluid for a nuclear power plant. *By I G McChesney, Rochester Gas and Electric Corp, and R H Shannon, United Engineers and Constructors, Inc.*

For a fast solid-fuel (heterogeneous) type power-breeder reactor, liquid sodium is one of the best coolants for removing heat energy from the reactor. But for the power cycle with water as the thermodynamic working medium, it is desirable to consider ways of eliminating or minimizing possibility of contact between sodium and water, because a violent chemical reaction can occur.

Potential hazard in this application is much greater since sodium is also radioactive. In addition, it is important to keep neutron moderating elements out of the core of a fast reactor.

By means of cycle studies the authors find a benzene plant may well be as expensive as the combined cost of the steam plant and the NaK coolant system. Benzene involves additional hazards in plant operation and maintenance. Potential danger of moderating elements getting into the sodium coolant still exists. *ASME paper no. 55-S-29.*

Piping

Steam-piping design to minimize creep concentrations. *By E L Robinson, General Electric Company.*

This paper gives a selection of formulas for determination of possible creep concentrations in high-temperature piping. Some specific arrangements likely to be conducive to concentration of plastic strain are illustrated. Excessive plastic strain is undesirable, although the amount that can be tolerated varies greatly between different materials.

The two most important assumptions made during the analyses are that creep goes with some power of the stress and that progressive using up of the material goes with the octahedral stress where both torsion and bending are present.

In trying to decide if a structure is safe and useful, it is well to remember that fracture and failure come about through a separation of one part from another. This, very literally, is a change of shape technically called strain. Stress, as such, is just an intermediate means by which strain is caused. *ASME paper no. 54-A-186.*

Endurance testing of expansion joints. *By Walter Samans, Consulting Engineer, and Dr Leo Blumberg, Pennsylvania Military College.*

Although it was first thought in these tests that there would be more or less uniformity in the behavior of joints along some generalized classification as to bellows shape, irregularity prevailed. Only in a few cases did two joints from the same manufacturer have about the same flexure life.

Items important in setting up design rules included the following. Free spring in a joint after manufacture, and as received by the user, is relatively insignificant in determining the probable flexure life of a joint, when several types of stress raisers may exist to cause a premature failure.

Stress concentrations at circumferential edge welds were the apparent primary cause of failure in all disk-type joints tested. Stress concentrations in longitudinal welds were the apparent primary cause of failure in three of the hydraulically formed types of joints tested. *ASME paper no. 54-A-103.*

Carbon-molybdenum steel steam pipe after 100,000 hours of service. *By R J Sinnott and I A Rohrig, The Detroit Edison Co, and J W Freeman and A I Rush, University of Michigan.*

When unit No. 14 was erected at Delray Power Plant in 1938, lack of reliable data on service-life properties of metals subjected to high temperatures was acutely felt. The practice of basing design stresses on short-term high-temperature laboratory tests was repeatedly questioned.

Rarely does the engineer have opportunity to check design considerations and laboratory data in terms of creep in service. Samples from piping in this

(*Continued on page 224*)

Directions for ordering papers on p 232

Traveling Stocking and Reclaiming Coal Handling Tower

OF WELDED DESIGN

a Mead-Morrison development

All connections in the main structure of this tower, both shop and field, are welded. The cantilevers employ riveted connections and are fastened to the main structure by means of rivets.

This modern design is typical of Mead-Morrison pioneering in developing stronger and more economical material-handling equipment. Write for complete information on Mead-Morrison Towers and Bridges for coal, ore and other materials.

Coal is brought to the plant of a large West Virginia steel mill in cars which dump into a digging pit alongside the Mead-Morrison tower. Unloading of the cars is aided by a car shakeout suspended from the side of the tower.

The tower digs coal from the trough and delivers it to the near-side stocking pile at the rated capacity of 915 tons per hour, and to the far-side stocking pile at the rated capacity of 610 tons per hour.

The tower also reclaims coal from the storage piles to the receiving hopper in the tower at the rated capacity of 765 tons per hour from either pile.

Included in the Mead-Morrison equipment are a 6½ ton lightweight grab bucket and automatic rail clamps to protect the structure in a high wind. Adjustable voltage is used for the hoist, close and trolley motions, and constant voltage for the propelling motors.

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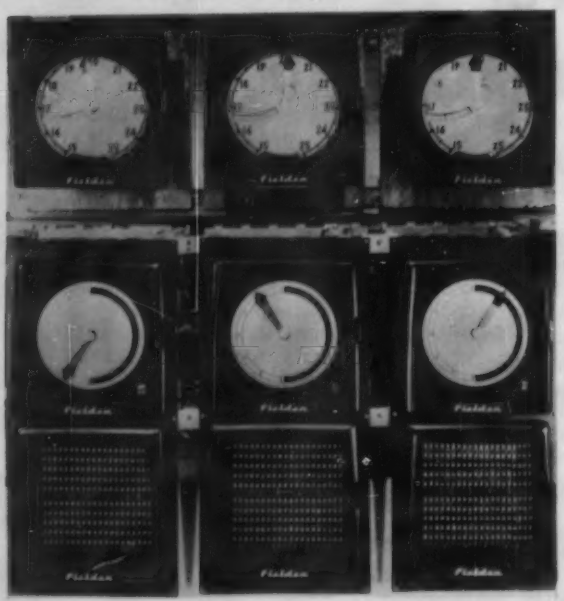


Electronic indicating scanner can continuously test unlimited number of industrial processes

606 • Electronic instrument makes it possible to test and control continuously an unlimited number of industrial processes from a single vantage point. The instrument, called an indicating scanner, monitors a variety of process variables involving level, temperature, thickness, mechanical movements, tolerances, weights and pressure. It will keep a steady check on 6, 12, 24, 48 and more steps in a manufacturing process, company claims.

Speed of scanning depends largely upon number of points to be checked, with a maximum rate of one point per second. Where there is a process that strays beyond the pre-set control zone, scanning stops at that point and actuates an alarm or flashes a signal. Indicator dial shows extent of the deviation. Associated control systems may automatically correct the condition.

Illustration, left, shows three identical 76-point scanning instruments. Units at top indicate temperature of each step in process as it comes under control. Units in middle tell which step is being controlled. If temperature deviates from prescribed setting, instrument will stop automatically, showing attendant both the location and extent of trouble. To re-start scanner, attendant presses reset button. Scanner will stop on over-temperature again unless condition is corrected or a by-pass connection made through use of sliding connectors shown in the bottom case.

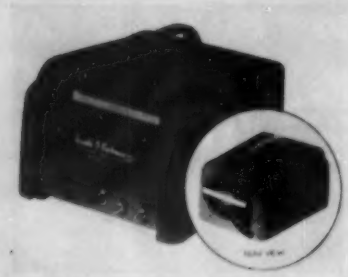
Fielden Instrument div, Robertshaw-Fulton Control Co, 2920 North Fourth St, Philadelphia 33, Pennsylvania

Ac clamp volt-ammeter

607 • Lightweight instrument incorporates self-shielded mechanism with spring-backed jewels. Scale window is of shatter-proof *Plexiglass*. Instrument contains 6 current ranges of 300, 150, 60, 30, 15 and 6 amperes; and 3 voltage ranges of 600, 300, 150 volts.

To simplify reading, a single scale is employed for all ranges and functions which are selected through a thumb selector switch. Neoprene covered clamping jaws are tapered for measurements in limited areas. Accommodates conductors to 1-in. round or 1⅝x⅝-in. rectangular. Further details on request.

Weston Electrical Instrument Corp, 614 Frelinghuysen Ave, Newark 5, New Jersey



Portable oxygen analyzer

608 • Portable instrument can be used for measuring continuously-flowing samples, or for fixed volume samples as small as 3 cc. It can be obtained in practically any desired range of 5% or more between 0 and 75% oxygen—and in ranges of 15% or more between 75 and 100% oxygen. Accuracies in any range are within ±1% of full scale.

Response is rapid—95% response to final reading within 40 seconds on standard models, or within 7 seconds on special models. Scale is direct reading and may be calibrated in either percent oxygen or millimeters of mercury oxygen partial pressure.

Arnold O Beckman, Inc, 1020 Mission St, S Pasadena, Calif.

Absolute pressure indicator

609 • Instrument has a range from 0.1 to 20 mm Hg and an expanded scale in the 0.5 to 5 mm range. It operates on 115-v dc. Noble-metal thermocouples are housed in nickel-plated gage tubes to afford freedom from out-gassing, system contamination and corrosion.

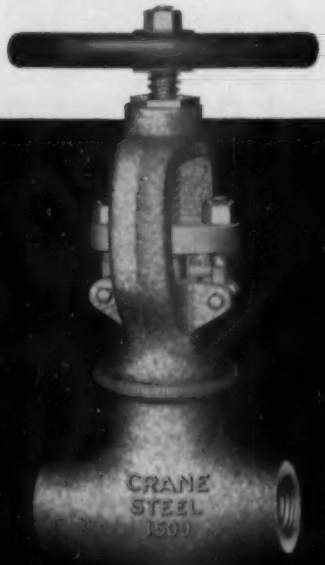
Being electrical in nature, any standard strip chart millivolt recording instrument capable of operating from 10 millivolts or less is suitable for recording pressure data from this indicator. Instrument is practical for remote installations and may be calibrated from any length cable from indicator to gage tubes. Full details on request.

Hastings Instrument Co, Inc, Hampton, Virginia

For more data on these items, use post cards, page 173. Identify your request with item number.

Why buy small high pressure valves that lack these CRANE features?

New 1500 and 2500 pound check patterns . . . screwed or socket welding ends; ½" to 2". Patented construction assures high disc lift, free flow and minimum pressure drop.



1500 and 2500 pound globe patterns... screwed or socket welding ends; ½" to 2".

1500 and 2500 pound angle patterns... screwed or socket welding ends; ½" to 2".

When you buy CRANE Lip-Seal Bonnet Valves . . . designed exclusively for high pressure/high temperature power plant service . . . you are assured of:

- lip-seal welds that are laid on flat surfaces—needn't be chipped out or burned out;
- easy dismantling and reassembly—bonnet screws out after weld is *ground away*—makes inside of valves entirely accessible;
- bonnet threads are chrome plated to prevent galling or seizing;
- stems that do not bind or gall—because of CRANE's exclusive ball-joint glands;
- easy access to stuffing box—swing-type gland eye-bolts swing free of yoke area, can't be lost;
- a more rigid swivel disc-stem connection that minimizes vibration;
- each size valve is a separate design for proper proportion—another CRANE exclusive.

Specify "Crane Lip-Seal" when you want small valves for high pressure/high temperature steam service. For more reasons why you should do so, ask your CRANE representative for Circular AD1902, or write direct. CRANE CO., General Offices: 836 S. Michigan Ave., Chicago 5, Ill. Branches and Wholesalers Serving All Industrial Areas.

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More EQUIPMENT NEWS

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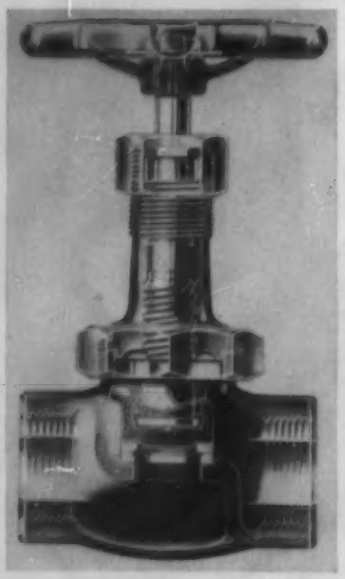
Five valve developments designed for today's power systems



Bronze globe valves use new seating metal

601 • Manufacturer claims that during a 4-year testing program these *LQ600* valves did not fail or leak—even in installations where other valves had to be replaced regularly.

This performance, according to manufacturer, is made possible by two new elements: (1) *Brinalloy*, a new seating metal that is hard all the way through, and (2) flat-seat design of the valve.

Brinalloy is said to resist wear and corrosion far more than 500-Brinell stainless steel or casehardened stainless steel exceeding 1000 Brinell. Seats and disks made of this material do not require replacement, renewing or regrinding, manufacturer states. Other features claimed include high-strength bronzes in body and bonnet, and true back-seating, permitting safe and easy repacking under pressure. Request bulletin 602 for further information.

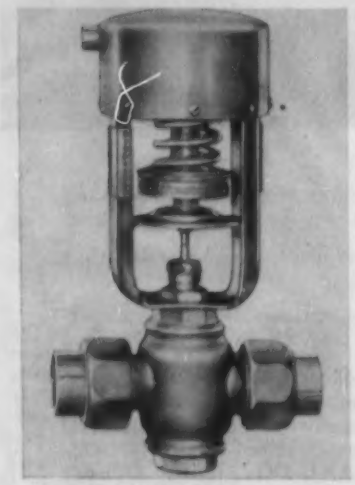
The Lunkenheimer Company, Box 360, Cincinnati 14, Ohio

Globe-type solenoid valves

602 • Claimed features of *Type K* solenoid valves include all stainless steel construction of parts in contact with media, cushioned closing, full port openings, and operation over a wide pressure range. Units are piston-pilot operated. Piston, pilot valve and spring are only moving parts operating in packless chamber. Request bulletin K.

J D Gould Co, 730 E Washington St, Indianapolis 2, Indiana

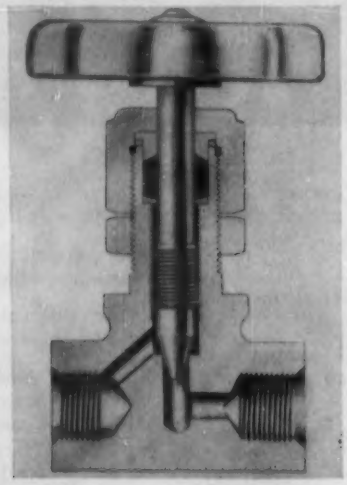
For more data on these items, use post cards, page 173. Identify your request with item number.



All-metal motor valve

603 • Valve, equipped with cadium-plated steel spring and two-ply seamless metal bellows, is used to control flow of steam, gas, oil, water and other fluids. It is employed as a final control element in pneumatic and hydraulic systems to maintain pressure, temperature or level in industrial vats, tanks and processes. Details on request to manufacturer.

Robertshaw-Fulton Controls Co, Box 400, Knoxville, Tennessee



High-pressure needle valve

604 • Body and stem guide are combined in this valve by use of a "T" shaped stainless steel forging. Result is a valve body without welds of any kind. Unit is designed for working pressures to 10,000 psi, at temperatures to 200 F, in water, gas, oil and vacuum service. Semi-needle stem is hardened stainless steel. Request bulletin.

Republic Manufacturing Co, 15655 Brookpark Rd, Cleveland 11, Ohio

Sweat-type gate valve

605 • Brass sweat-type gate valve is designed for copper-tube service. It is a solder-type unit for working pressures of 125 psi, 200-lb WOG. Sizes are ⅜ to 2-in. Claimed features are non-rising stem, solid wedge disk construction, uniform outlets and accurately machined moving parts. Further details on request to manufacturer.

Milwaukee Valve Co, 2375 S Burrell St, Milwaukee 7, Wisconsin

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HEAT EXCHANGERS

Now rated for many applications . . . selection made easy

Two new catalogs on B & G Type "WU" and "SU" Heat Exchangers make it a simple matter to quickly select equipment for water-to-water and steam-to-water heat transfer applications.

Ratings are given for instantaneous heating of water for service use—radiation—snow melting panels—swimming pools—boiler feed—storage tanks—and process work.

The "WU" Heat Exchanger is particularly notable for its ability to deliver a large volume of hot water from a small unit. Boiler water is pumped through the Exchanger by a B & G Booster, greatly increasing capacity and permitting close control of service water temperature. Reduction in pipe and fitting sizes and less installing labor materially cuts the original cost.

Many most commonly used sizes of "WU" and "SU" Exchangers are available from factory stock, ready for immediate shipment. Send today for your copies of "WU" Bulletin No. GC-1054 and "SU" Bulletin No. GN-1054.

For industrial service water heating

For laundries, restaurants, and hotels

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BELL & GOSSETT COMPANY

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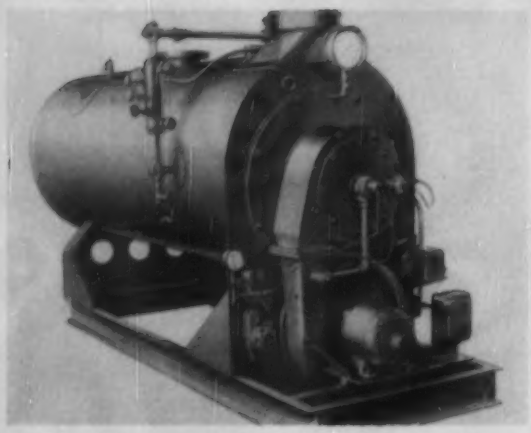
More EQUIPMENT NEWS

Begins on page 164

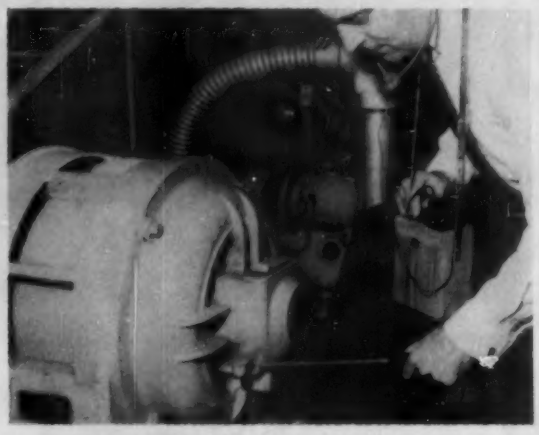


Combination steam-hot water generator

619 • Combination boiler is expected to find wide use in industrial plants that are heated by hot water but have occasional use for steam (such as steaming out tanks, degreasing and limited processing). Unit is basically a hot water generator, but a few simple adjustments convert it to steam operation. It operates on light oil, gas or a combination of light oil and gas. Unit is rated as a 60-hp steam or hot water generator. Changeover is a simple procedure.

As a hot water generator, unit generates 2,010,000 Btu per hr. Working pressure is 30 psi and it will deliver 2480 gallons of hot water per hr with a 100 F rise in temperature.

As a 60-hp steam generator, unit delivers 2070 lbs of steam per hr. Operating pressures ranging from 15 to 200 psi can be manufactured as standard equipment. Full details on request.
Cyclotherm div, U.S. Radiator Corp, Oswego 1, N. Y.

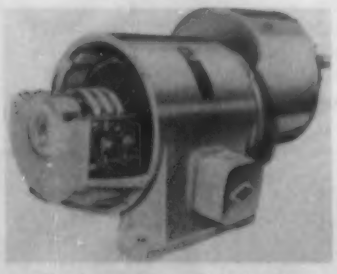


Detector locates mechanical troubles

620 • *Auditec* is an electronic instrument consisting of a metal probe and amplifier with controls for sensitivity and volume. It is used to (1) locate and diagnose mechanical troubles in machinery, (2) locate leaks and valve defects and diagnose flow volume in pipelines, etc, (3) detect surface flaws in metal and other smooth surfaces, (4) conduct quality control tests for mass production and repetition products.

When probe is placed in contact with suspected source of noise, sound vibrations are amplified hundreds of times. Pinpointing precise location of trouble is accomplished by moving probe to different places until noise is at its loudest. By use of the controls, sound can be identified and analyzed to tell cause of the trouble. Unit is housed in carrier case and provided with lightweight headphones. Full details on request.
John Ould (USA) Ltd, 516 S 5th Ave, Mt Vernon, N. Y.

Three recent developments in mechanical transmission equipment



Packaged speed reducer

616 • Units can provide variable speed reduction and high starting torque on low starting current. Because of these features they can start heavier loads than conventional motors of the same hp rating, manufacturer states.

Package units are available in ratings from ½ through 5 hp, and in speed reductions of 520 through 16 rpm. Drive motor may be either drip-proof or totally enclosed. Bulletin SR-1007.
Reuland Electric Company, Alhambra, California

Speed reduction units

617 • Motorized speed reduction units are available in 28 standard stock models with general purpose or totally-enclosed motors in 13 sizes from 1/6 to 10 hp. Combination construction permits removal of motor without disturbing gear reduction unit.

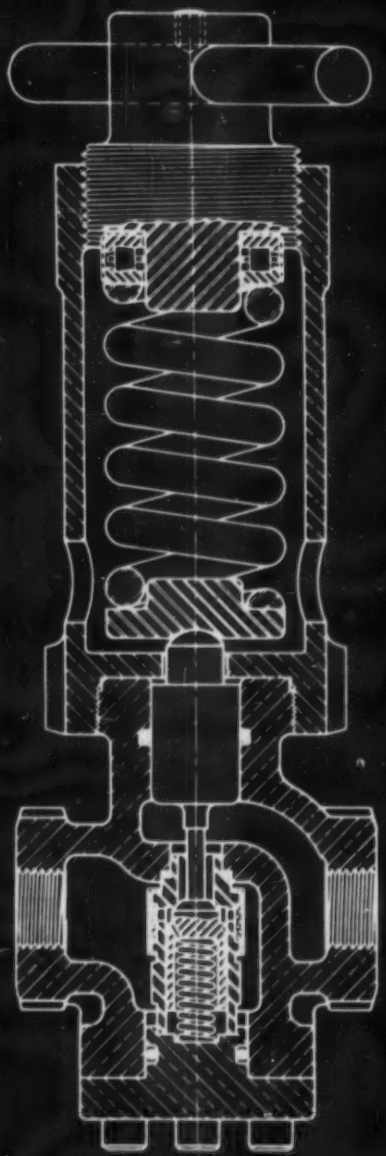
Unit is also available without motor with ratios from 10:1 to 3600:1, and output torque ratings from 50 to 9400 in. lbs. Bulletin obtainable on request.
Boston Gear Works, 104 Hayward St, Quincy 71, Massachusetts

Variable speed pulley

618 • Unit provides ratios to 3:1 at from 7½ to 15 hp. Easily installed on new or old equipment, unit changes speed at finger-tip pressure while machinery is in motion. Used in conjunction with a 1750-rpm motor, maximum hp is 15; with a 1150-rpm motor, maximum hp is 10. Standard bores are 1¼, 1⅝ and 1⅞-in. Pitch diameter is 13.1 maximum and 4.35 minimum. Complete details on request.
Lovejoy Flexible Coupling Co, 4870 W Lake St, Chicago 44, Ill.

For more data on these items, use post cards, page 173. Identify your request with item number.

A RUGGED, DEPENDABLE VALVE FOR HIGH-PRESSURE APPLICATIONS



CASH STANDARD

TYPE 345

Pressure Reducing and Regulating Valve

Designed for hydraulic presses, hydraulic systems, die-mold apparatus and high pressure pneumatic systems (oxygen, nitrogen, hydrogen).

- For use on air, water, oil and various gases (not for steam)
- Inlet pressures: 500 to 4000 psig
- Delivery pressures: 400 to 3000 psig
- Bronze or steel construction
- Piston-operated with O-ring seals
- T-bar adjusting screw combined with roller thrust bearing for ease of adjustment
- Internal strainer screen
- Corrosion resistant
- Operating fluid around renewal unit results in equal expansion and contraction of internal mechanism, precludes sticking or seizing
- Easily serviced without removal from line
- Renewable inner units of nitrided or stainless steel. For severe conditions, stellite facing is available
- Screwed ends, sizes ½", ¾", 1"

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CASH CS STANDARD

A. W. CASH COMPANY • P.O. BOX 551, DECATUR, ILL.

PRESSURE, HYDRAULIC, TEMPERATURE, PROCESS AND COMBUSTION CONTROLS

More EQUIPMENT NEWS

Begins on page 164

Pumps and accessories—3 timely items

Vertical electric pump motor features non-reverse ratchet

610 • Vertical hollow-shaft pump motor is equipped with a ball-type, non-reverse ratchet, claimed to give positive protection against backspin. Heretofore, when a non-protected vertical turbine pump was shut down and fluid column receded, resulting backspin often damaged the pump and its drive motor. New ratchet in this pump motor locks within 1/72 of a revolution, physically preventing motor and pump from rotating in reverse. Entire ratchet assembly is mounted at top of motor for easy installation, inspection and maintenance.

Other features, claimed by the manufacturer, include overhung, canopy-type hood for full protection against the elements; heavy-duty, single-row ball thrust bearings; high capacity centrifugal-fan cooling; and dynamically balanced rotors.

Motors are available in all sizes up to and including 200 hp. Four-page descriptive bulletin containing complete details obtainable on request to manufacturer.

ACEC Electric Corporation, 40 E 49th St, New York 17, N. Y.

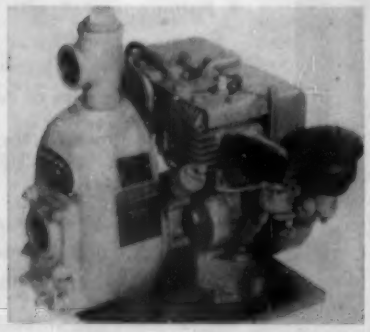
Controlled volume pumps

611 • Unit is engineered for precise control of fluid flow at pressures ranging from 7500 to 50,000 psi. Maximum capacity at 50,000 psi is 12.5 gph; at 7500 psi maximum capacity is 94 gph.

Pump is recommended for high pressure syntheses, hydrostatic pressure testing and high pressure fluid metering. Manufacturer states that unit provides precise metering accuracy at higher capacities as well as at higher pressures.

Pumps, below 25,000 psi capacity, are constructed of 300-series stainless steel with 400-series trim. Above 25,000 psi, materials used are Ni-Cr-Mo steel with tungsten carbide trim. Details on request.

Milton Roy Co, Station D, 1300 E Mermaid Lane, Philadelphia, Pa.



Aluminum alloy pumps

612 • These centrifugal pumps, built of aluminum alloys, are said to average 1/3 the weight of conventional cast iron pumps of like capacity. Capacities range from 5500 to 18,000 gph.

Pumps are powered with 4-cycle, air-cooled engines and are equipped with high tension magnetos, oil bath air cleaners, gas filters, governors, throttle controls and rope starters. Features, according to manufacturer, include non-clogging impeller to handle liquids carrying a high percentage of solids; replaceable pump liners; and fast self-priming action. Same pumps are also available in cast iron construction. Request bulletin 55LW for additional information.

Rice Pump & Machine Company, Belgium, Wisconsin

For more data on these items, use post cards, p 173. Identify your request with item number.

Teflon plastic packing

613 • This packing is composed of shredded *Teflon* combined with suitable binders and lubricants extruded into an open cotton yarn jacket impregnated with graphite. It is also available impregnated with mica for use in food industry or wherever a non-contaminated packing is essential. Serviceable from –150 to 550 F, it can be used on all packing applications (dynamic or static) that require the chemical resistance of *Teflon*. Full details on request.

Flexrock Co, Packing div, 3677 Filbert St, Philadelphia 1, Pa.

Pipe thread compound

614 • Plastic lead seal thread compound is available in polyvinyl plastic tubes. UL approved, this compound is said to withstand pressures to 6000 psi, temperatures to 600 F and is insoluble in water, steam, gas, refrigerants, many chemicals and all petroleum products. It provides a permanent seal, yet is non-hardening—permitting easy disassembly of connections.

Polyvinyl plastic tubes will not crack at seams or separate at bottom crimp, so often encountered with other tubes. Further information on request.

Crane Packing Co, Dept PRN, 1800 Cuyler Ave, Chicago, Ill.

Smoke alarm system

615 • Unit, consisting of light source, cell and indicator, permits choice of mounting lamp and cell to fit practically any installation requirement. Sensing unit employs a cadmium sulphide cell eliminating need of pre-amplifier mounted at the breech. Indicator is sensitive, activated by slightest change in density of the combustion gases, manufacturer states. A thyatron operated relay is capable of handling up to 5 amps at 115 v and may be connected to associated warning equipment.

Instrument chassis has plug-in connection to outer case for ease in maintenance. No tools are required for change of lamp bulbs or tubes. System is designed for continuous duty, drawing about 15 w at 110-120 v, 60 cycle.

Smok-Trol Corp, 10 St Paul Pl, Ossining, New York

CHECK THESE TOO . . .

Hot water heating system . . . . p 178
Overhead conveyor chains . . . p 180
Evaporative condensers . . . . . p 184
Spring machinery mount . . . . p 186
Electric generating plants . . . p 190
10-lb fire extinguisher . . . . . p 194
Rubber expansion joints . . . . p 196
Multifunction alarm system . . . p 198
Isolated phase bus . . . . . p 200

CLEAVER-BROOKS SELF-CONTAINED BOILERS HAVE THE FEATURES EVERYONE WANTS!

...which feature would be most important to you?

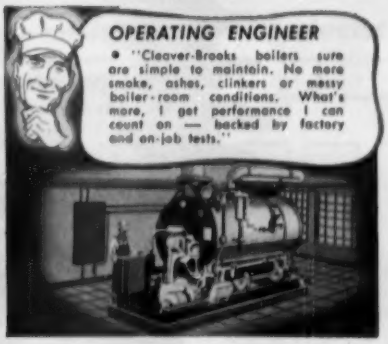
PLANT OWNER
• "Cleaver-Brooks boilers are tops in fuel economy! Forced-draft, four-pass construction and 5 sq. ft. of heating surface per boiler H.P. assure me 80% operating efficiency when firing with oil."

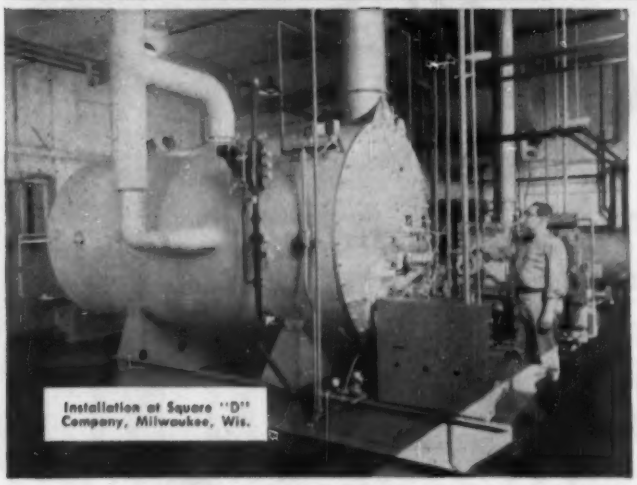
ARCHITECT
• "Self-contained design certainly simplifies boiler room planning — gives owners maximum use from each square foot of space. Gives me flexibility to make best use of low head room conditions."

CONSULTING ENGINEER
• "Oil, gas and combination oil/gas firing lets me recommend Cleaver-Brooks boilers for installation anywhere. Exclusive burner design makes it possible to interchange gas/oil firing in 10 seconds."

CONTRACTOR
• "Boilers are shipped ready to install. With service lines in, my crews have boilers ready for operation in 24 hours or less after delivery. No foundation or stack problems. Cleaver-Brooks furnishes starting service, too."

PLANT SUPERINTENDENT
• "I get all the steam I need for fluctuating steam demands, from full load down to 30% of rating. Automatic burner controls assure instant firing. I call that real dependability."


OPERATING ENGINEER
• "Cleaver-Brooks boilers sure are simple to maintain. No more smoke, ashes, clinkers or messy boiler-room conditions. What's more, I get performance I can count on — backed by factory and on-job tests."



THESE are just a few of the many outstanding features that have made more than 15,000 individual Cleaver-Brooks self-contained boilers *first choice* for commercial, institutional and industrial applications. Get in touch with your nearest Cleaver-Brooks representative for complete facts, or write for catalog AD-100. Cleaver-Brooks Co., Dept. G, 301 E. Keefe Ave., Milwaukee 12, Wis., U.S.A. — *Cable address: CLEBRO — Milwaukee — all codes.*

Cleaver Brooks

"It's NEW — get the facts on the CB boiler — write today!"

BOILERS — STEAM OR HOT WATER — FOR HEATING OR PROCESSING IN SIZES FROM 15 TO 500 HP, 15 TO 250 PSI.

NOW — FIRST SIZES OF THE CB BOILER ARE MADE IN CANADA, TOO.

pounds

NOT GUESSES

Builders Shuntflo Steam Meter keeps track of steam costs by showing you *where* steam is going and *how much*. Write for Bulletins. Builders-Providence, Inc., 354 Harris Ave., Providence 1, R. I.

BUILDERS-PROVIDENCE

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VENTILATING, HEATING, REFRIGERATION

1 **Heavy duty industrial fans,** *Class II and III* are described in 20-page bulletin 644. Includes data on construction, arrangement and application, accessories, plus photos and capacity tables. The New York Blower Company, 3155 S Shields Ave, Chicago 16, Illinois.

2 **Electric heating** of heavy fuel oils is subject of 8-page bulletin 1644B. Diagrams and specs. Preferred Utilities Manufacturing Corp, 1860 Broadway, New York 23, New York.

3 **Fused-quartz radiant heaters** for baking paints, curing foundry cores, forming plastics, etc. Illustrated 4-page bulletin RLC-109. Cleveland Process Company, 1967 E 67th St, Cleveland 3, Ohio.

4 **Absorption refrigerating machines** ranging from 100 to 700 tons capacity, are described in 36-page bulletin 30-F-22. Contains photos, engineering and application data, capacity charts. Carrier Corp, Syracuse, New York.

BOILERS AND AUXILIARIES

5 **Thermal liquid heater** is designed for continuous operation at temperatures to 750 F. Photos, diagrams, typical applications in 8-page bulletin. The International Boiler Works Company, East Stroudsburg, Pennsylvania.

6 **Steam heating specialties.** Illustrated 8-page bulletin 201 contains data on radiator valves, thermostatic traps, vapor systems and boiler room specialties. Illinois Engineering Co, 2036 S Racine Ave, Chicago 8, Illinois.

7 **Tube expanding equipment** for fire-tube boilers, water-tube boilers, condensers, etc. Photos, diagrams in 4-page news bulletin. The Gustav Wiedeke Co, Dayton 1, Ohio.

CONTROLS

8 **General purpose controls.** 68-page catalog GEC-1360A contains photos, wiring diagrams, dimensions on motor starters, contactors, relays, solenoids, switches, push buttons, etc. General Electric Co, Schenectady 5, New York.

9 **Thermostatic controls** is subject of 8-page illustrated bulletin C-6. Includes data on temperature regulators, tempering valves, water controllers, water pressure equalisers, hospital equipment. Lawler Automatic Controls Inc, 453 N MacQuesten Pkwy, Mt Vernon, N. Y.

10 **Pneumatic indicating controller** for control of process variables such as temperature, pressure, liquid level, humidity. Photos and specs in 12-page bulletin 5A-13. The Foxboro Company, Foxboro, Massachusetts.

11 **Temperature control.** Adjustable remote-bulb units, in two temperature ranges—40 to 250 F and 200 to 550 F—are described in 2-page bulletin MC-151. Photo, diagrams, specs. Fenwal Inc, Ashland, Massachusetts.

12 **Control system** for regulation of frequency, schedule and interchange through use of servo controllers. Photos, full descriptions in 12-page bulletin 9060. Minneapolis-Honeywell Regulator Co, Industrial div, Wayne & Windrim Avenues, Philadelphia 44, Pa.

13 **All-electronic control system** for process and power instrumentation. Four-page bulletin A1.3-1 illustrates and gives brief description of each unit in the *Astronic* control system. The Swartwout Co, 18511 Euclid Ave, Cleveland 12, Ohio.

ELECTRICAL EQUIPMENT

14 **Electric motors.** Illustrated 28-page catalog GEC-1026 present complete buying information on standard ac fractional and integral hp motors in most general use. General Electric Co, Schenectady 5, New York.

15 **Fully-protected motors,** *Type H-Unicased,* are described in illustrated 12-page bulletin 1856. Color views, photos, cutaways, design features and specs. U.S. Electrical Motors Inc, Box 2058, Los Angeles 54, California.

(Continued on page 218)

Balance, too, is important in
COOLING TOWERS

In the new CW SERIES COOLING TOWERS Marley engineers have achieved a high performance level that takes these counter-flow towers out of the "conventional" class. A carefully balanced expansion of three major elements results in more cooling ability for every frame size. CW towers offer:

GREATER FILL VOLUME – with more wetted surface in each cubic foot

GREATER AIR VELOCITIES – more pounds of air to pick up heat

GREATER SPRAY BREAK-UP – high pressure down spray on closer centers

There is the correct amount and type of fill to balance the increased air velocity; proper spray pressure to perform adequately with added fill and air flow. Of greatest importance is the skillful integration that makes the expanded features perform at a new low cost per gpm. This balance carries through to the fan, Geareducer, fan cylinder and drive shaft, all Marley designed to function as a unit at higher velocities for longer life.

MARLEY

The Marley Company

Kansas City, Missouri

George Edwards' Scrapbook

You're complaining?

Next time you get ready to throw yourself onto the ash heap because you feel you're licked, think of the great difficulties that Abraham Lincoln overcame:
1831, failed in business
1832, defeated for State Legislature
1833, again failed in business
1834, elected to State Legislature
1836, suffered nervous breakdown
1838, defeated for speaker
1840, defeated for elector
1843, defeated for Congress
1846, elected to Congress
1855, defeated for Senate
1856, defeated for Vice President
1858, defeated for Senate
1860, elected to Presidency of the United States.

Looking ahead

"Growth potential of the electrical manufacturing industry in the next decade is reliably estimated to be more than twice that of the rest of the national economy."

—A Vinson, GE Vice President

If you say you can't...

"The minute you say a thing cannot be done you are through with that thing. No matter how much you know—even if you are an expert, if you say it can't be done, you are through. Someone knowing nothing about it but thinking it can be done becomes a better man for that job than you."
—Dr Harry Meyers

Try being positive

"We won't roast each other any more," said the general manager to his department heads one day. "We've been blaming each other all year because this firm is losing money. From now on, we'll concentrate on solving our problems. So forget the past, think only of improvement for the future."

That little speech brought surefire results. Today, that company is in the black. Everyone is happy because no one wastes time harping on past mistakes. They use their energies for the future. After 19 months, the firm is again making money. This positive attitude works wonders in our home, on our job—and everywhere else. Only way to get ahead and enjoy life is to have a positive, cheerful attitude. Try it.

Pigs and engineering

Union Stock Yards in Chicago is largest in our country. For years they had trouble unloading pigs from trucks. That sounds easy, but it isn't—or, at least, it wasn't.

You see, the problem was getting pigs to go down a ramp into pens. Yard workers would place the sloping ramp against the truck, open the truck gate and start beating the truck's side with clubs, yelling at the top of their voices. But the scared pigs would squeal and crowd farther back in the truck. Finally, men would have to go into the truck and start pounding the pigs. After much cussing, beating, yelling and squealing, the truck would eventually be unloaded. But it often took over an hour to do what should have taken a few minutes. Wasted time held up production and cost money.

Problem was solved a few years ago when a new manager was put in charge of the yard. And he solved it because he had an inquisitive mind even though he knew nothing about livestock. As he hadn't seen what most people around the yards accepted as the only way to unload pigs, he asked *why* the pigs wouldn't go down the ramp as soon as they had a chance. No one had thought of it as a problem before, and no one knew the answer. So he experimented and found pigs walk down steps without any trouble.

Now, the former ramps have been replaced by ramps with steps. What was once a disagreeable and costly task is done quietly, with no lost motions or lost tempers.

How does this tie in with engineering? It has the most direct tie I can think of. Most of us don't see our real problems, in the first place. Silly? It's true. Engineering often needs an entirely new approach. For that reason a person knowing absolutely nothing of a subject can often solve it best. A newcomer isn't hampered by tradition. This problem was half solved as soon as the new boss asked the simple question, "Why won't pigs go down a sloping ramp willingly?"

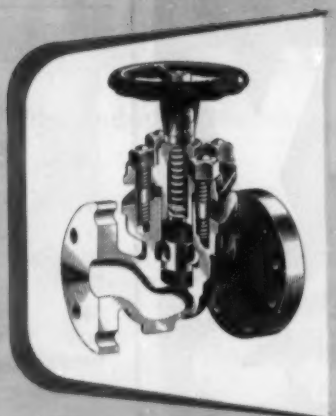
George Edwards
Engineer

"Klingerise" YOUR PLANT

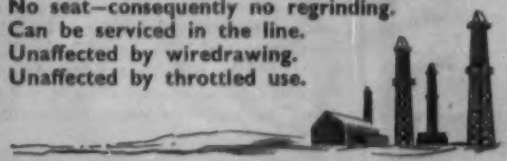
INSTALL KLINGER FITTINGS

KLINGER SEATLESS PISTON VALVES

The Klinger Seatless Piston Valve operates on an entirely different principle from the usual type of seating valve. It consists basically of a finely ground piston, operated by the valve spindle and hand wheel and moving through two or three non-metallic resilient valve rings, capable of resisting steam, oil and most fluids at high temperatures and pressures, and separated by a ported lantern bush. It is made in a great variety of sizes and designs, to suit all purposes, and has the following advantages:-



No seat—consequently no regrinding.
Can be serviced in the line.
Unaffected by wiredrawing.
Unaffected by throttled use.



KLINGER SLEEVE-PACKED COCKS

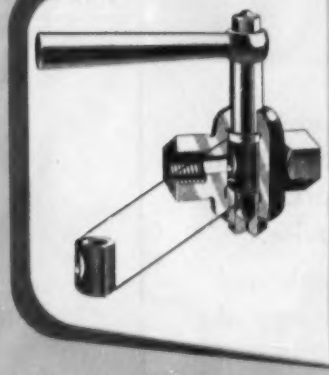
In the last quarter of a century Klinger Sleeve-Packed Cocks have steadily replaced the old-fashioned asbestos-packed cocks with their limitations of working pressures, difficulty of repacking and tendency to jam. They are available in a wide range of designs and sizes for all purposes and pressures, and with the following advantages:-

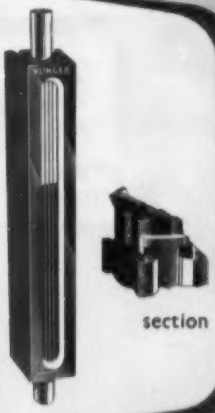
Renewable "Klingerit" packing sleeve.

Retightening during use.

Parallel-ground non-jam plug.

Unobstructed straight-thru full-bore passage.



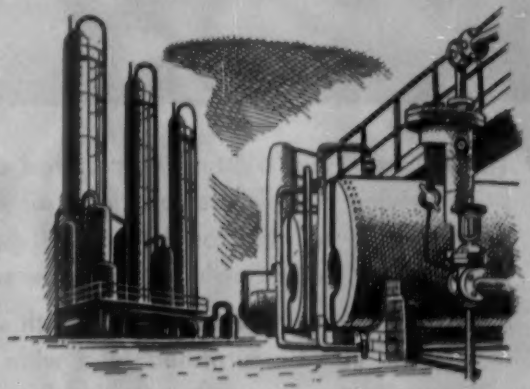


section

KLINGER REFLEX LEVEL GAGES

The "K" Type Reflex Level Gage has the following outstanding advantages:-

Single row of tightening bolts.
Body free from distortion.
Glass easily removed.
Gage body turnable, free to expand, and easily removed.



Write for the Klinger Master Catalogue which describes the complete range of Klinger products.

RICHARD KLINGER LIMITED, KLINGERIT WORKS, SIDCUP, KENT, ENGLAND

Cables: Klingerit — Agents throughout the world — Telephone: Foots Cray 3022

MANUFACTURERS OF KLINGER SEATLESS PISTON VALVES; KLINGER SLEEVE-PACKED COCKS; KLINGER LEVEL INDICATORS; RINGS AND SEALS IN KLINGER SYNTHETIC MATERIALS, AND KLINGERIT COMPRESSED ASBESTOS SHEET JOINTINGS AND PACKINGS FOR EVERY PURPOSE

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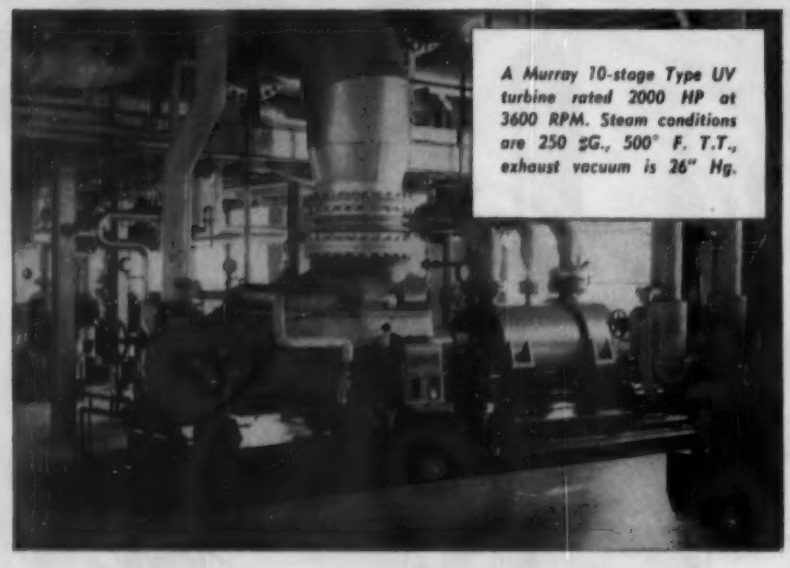
Distributors and Agents in principal cities.

Murray Turbines



A Murray 10-stage Type UV turbine rated 2000 HP at 3600 RPM. Steam conditions are 250 #G., 500° F. T.T., exhaust vacuum is 26" Hg.

● The Murray Type UV turbine pictured above has been driving a high pressure lean oil pump in a Southwestern refinery for the past 10 years. And is still giving dependable, trouble-free service.

Murray mechanical drive turbines both single and multi-stage can be furnished in a wide range of ratings for steam pressures ranging from 0 to 600 #G., condensing and non-condensing. Types in the higher pressures available for up to 250 #G. back pressure.

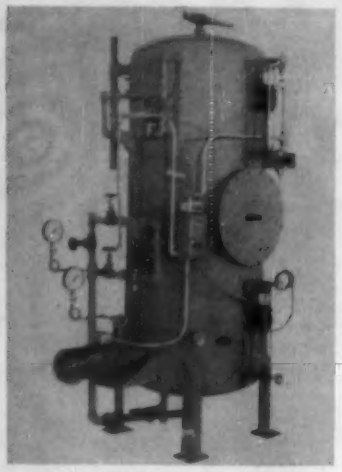
MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

More EQUIPMENT NEWS

Begins on page 164



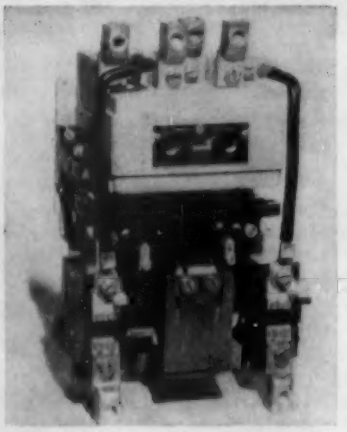
Hot water heating system

629 • System is said to be unique in its ability to provide a maximum amount of constant temperature hot water with a minimum amount of boiler hp available. This is obtained by utilizing a patented technique of constant average steam feed with "offset" cooling water temperature control, manufacturer states.

Heater is a direct-steam-mixing type with 100% efficiency and requires no return line. System is available for hot water loads to 900 gph. Non-packaged designs are available for loads to 20,000 gph. Request bulletin 920-A for details.

Fred H Schaub Engineering Co, 2110 South Marshall Boulevard, Chicago 23, Illinois

For more data on these items, use post cards p 173. Identify your request with item number.



Size 4 magnetic starter

624 • NEMA size 4, vertical-lift magnetic starter is said to be 40% smaller than previous models of the same size. Designed for motors up to 100-hp rating, unit is same size and has same mounting dimensions as the size 3 model, according to manufacturer. Permanent air gap causes the starter to drop out when de-energized regardless of age and usage, and a new type of bimetallic

"BIG ROCKER"

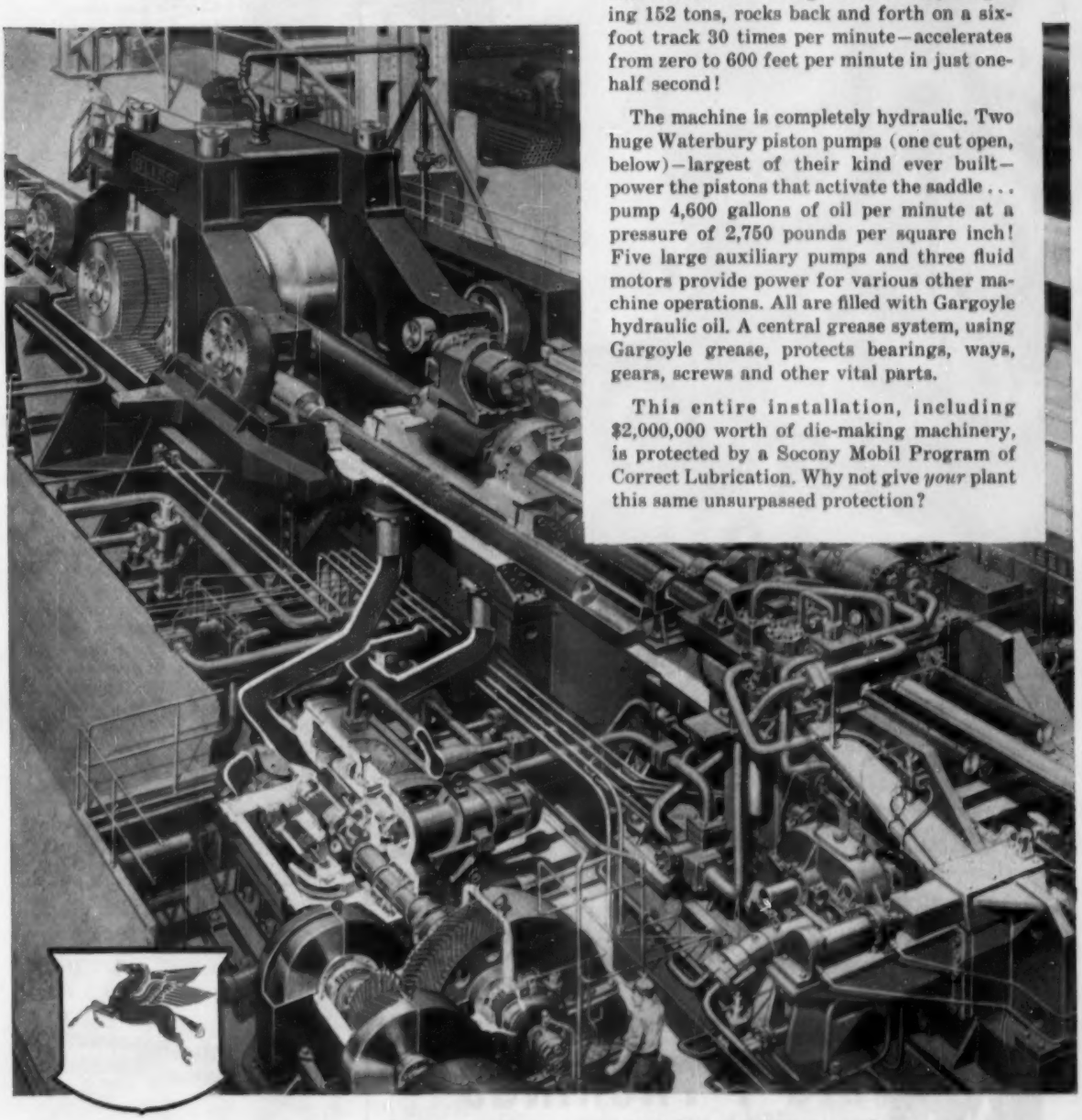
World's Largest Tube Reducing Machine Protected by the World's Greatest Lubrication Knowledge

It's 100 feet long, three stories high, weighs 675 tons! It's the world's largest tube reducing machine, built by E. W. Bliss Co., for the Tube Reducing Corp., Wallington, N. J. This giant takes rough, 18-inch O. D. cold steel tubing and reduces it to between 17- and 9-inch tubing. Finished tolerances are precise.

Heart of the Big Rocker is the "saddle" (top) which holds the huge dies that shape and stretch the tubing. This saddle, weighing 152 tons, rocks back and forth on a six-foot track 30 times per minute—accelerates from zero to 600 feet per minute in just one-half second!

The machine is completely hydraulic. Two huge Waterbury piston pumps (one cut open, below)—largest of their kind ever built—power the pistons that activate the saddle . . . pump 4,600 gallons of oil per minute at a pressure of 2,750 pounds per square inch! Five large auxiliary pumps and three fluid motors provide power for various other machine operations. All are filled with Gargoyle hydraulic oil. A central grease system, using Gargoyle grease, protects bearings, ways, gears, screws and other vital parts.

This entire installation, including $2,000,000 worth of die-making machinery, is protected by a Socony Mobil Program of Correct Lubrication. Why not give *your* plant this same unsurpassed protection?



SOCONY MOBIL *Correct Lubrication*

FIRST STEP IN CUTTING COSTS

SOCONY MOBIL OIL COMPANY, INC., and Affiliates: MAGNOLIA PETROLEUM COMPANY, GENERAL PETROLEUM CORPORATION

Formerly Socony-Vacuum Oil Company, Inc.

PRACTICE PREVENTIVE MAINTENANCE

WITH R/M's BIG 7 PACKING TYPES

No longer do you have to settle for costly, time-consuming corrective maintenance measures. You now can do as thousands of other plants have done: *set up a schedule of preventive practice* with R/M's Big 7 Packing Types. Their custom-built construction will provide you with superlative replacement performance—except in the very rarest applications. Most plants have found that they need only three or four to meet all their needs. By standardizing on them, they have reduced downtime, cut costs, lowered inventories, and simplified ordering. To find out how you can do the same, ask your R/M distributor for the R/M Big 7 Recommendation Chart.

R/M's BIG 7 PACKING TYPES MEET 95% OF ALL PACKING NEEDS

R/M Packings for maintenance purposes are sold only through authorized R/M distributors

R/M **BIG 7 PACKINGS**
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, MANHEIM, PA.

FACTORIES: Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Packings • Asbestos Textiles • Industrial Rubber, Engineered Plastic, and Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Bowling Balls

More EQUIPMENT NEWS

Begins on page 164

overload relay provides overload protection comparable to that available in smaller sizes.

Suitable for operation of polyphase motors in ratings of 220-v, 50 hp and 440/550 volts, 100 hp, the unit is available in reversing, multi-speed and combination forms. It can be obtained with either vertical or horizontal mechanical interlocks.

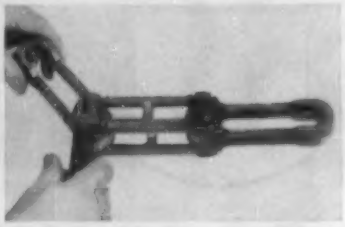
General Electric Company, Schenectady 5, New York

Force balance transmitter

633 • Unit measures differential pressures and transmits a 3-15 psi signal to a receiving, recording or controlling instrument. It provides continuous adjustment over the entire range of 0-50 to 0-250 in. of water differential without change of parts. Unitized "block" construction of 3 basic parts —body, transmitter and air relay—is said to eliminate effects of piping stresses. Operating on the force balance principle, the all-metal measuring components and temperature-table parts maintain calibrated accuracy over a wide range of ambient conditions, according to manufacturer. Silicone-filled capsule automatically dampens and filters flow "noises" at measurement source, yet permits high speed response to actual flow. Further details on request.

The Foxboro Co, Foxboro, Mass.

For more data on these items, use post cards p 173. Identify your request with item number.

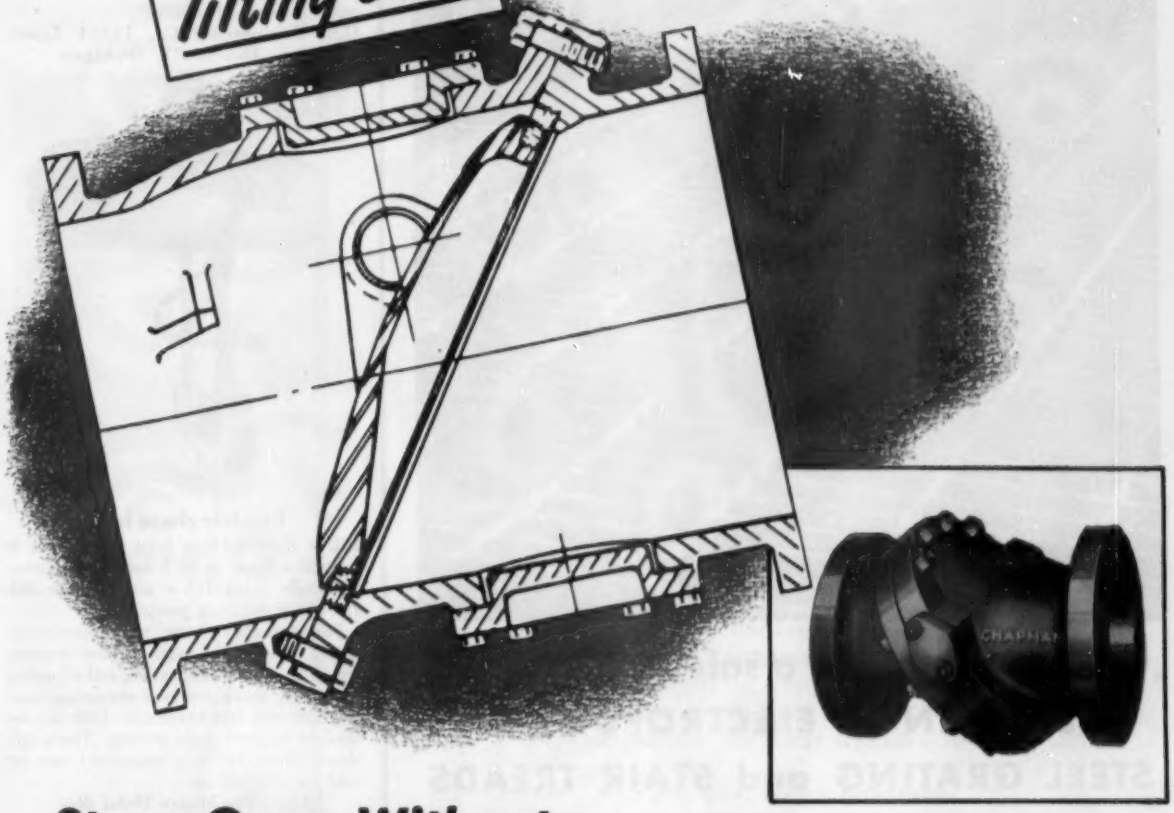


Overhead conveyor chains

625 • Drop-forged rivetless chains for overhead conveyor use are dimensionally interchangeable with other makes. Features, according to manufacturer, are dry lubricant impregnated pins and machined bear-

CHAPMAN'S

Tilting Disc CHECK VALVE



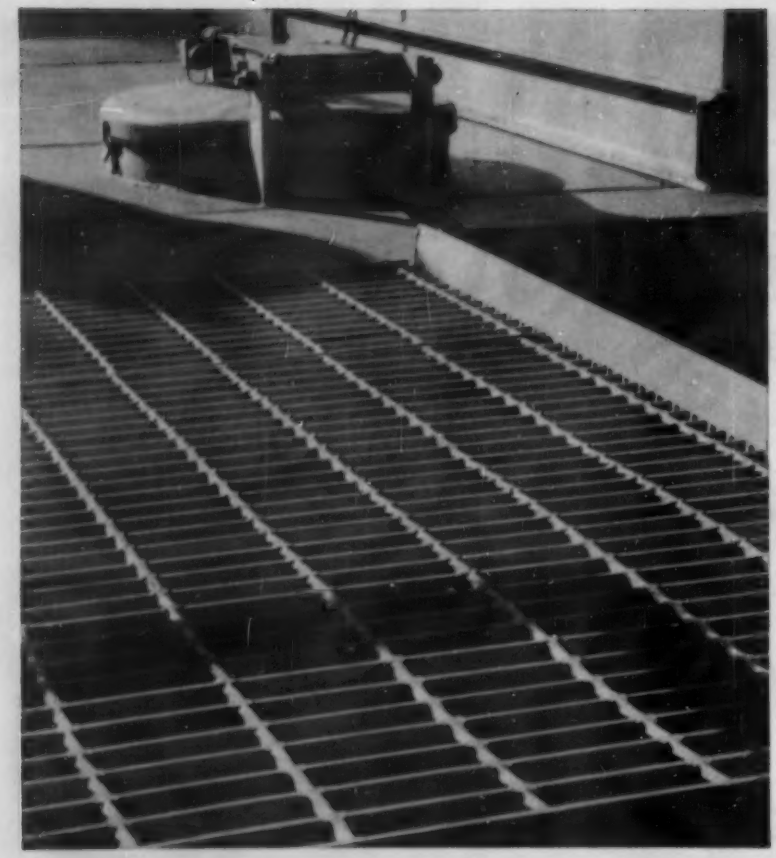
Stays Open Without Flutter, Closes Fast Without Slamming

Chapman's Tilting Disc check valve keeps maintenance costs down in the entire piping system. There's no flutter or vibration in the open position: the lightweight, airfoil-designed disc is held firmly against its stops by the fluid flow.

When flow starts to reverse, the uniquely designed disc swings quickly to the closed position, cushioned by fluid pressures, and then drops to a tight seal against the seat, without sliding or scraping. Closure is fast, tight . . . and *quiet*. Slamming is *eliminated*, in all but unusual piping arrangements.

Freedom from vibration and slamming, low wear and low head loss keep maintenance costs down, give years of more efficient service. For every check valve service, specify Chapman's Tilting Disc. Available in steel or iron, with suitable trim to meet service conditions. Full engineering data are in Catalog 30. Write for it today.

The Chapman Valve Manufacturing Company
INDIAN ORCHARD, MASSACHUSETTS



... make every step a safe step

BLAW-KNOX ELECTROFORGED®
STEEL GRATING and STAIR TREADS

Indoors or outdoors, you can provide safe walking conditions throughout your plant on floors, stair treads, platforms, walkways and catwalks. For Blaw-Knox Electroforged Steel Grating brings you these exclusive features:

1. rigid one-piece construction—easy to install
2. non-slip twisted crossbar—for safe footing
3. three types of bearing bars
   - square bars—for smoothest walking surface
   - knurled bars (Furro-Grip)—for extra safety plus relatively smooth walking surface
   - serrated bars—for maximum safety under extremely hazardous skid conditions
4. no sharp corners to clog—self-cleaning
5. all surfaces accessible—easy to paint
6. maximum open area—for light and ventilation

Write for your copy of new Bulletin No. 2486
—or send dimensional sketch for quotation.

BLAW-KNOX

BLAW-KNOX COMPANY
BLAW-KNOX EQUIPMENT DIVISION
Pittsburgh 38, Pennsylvania

GRATING APPLICATIONS: floors • platforms • walkways • catwalks • stair treads • fan guards • shelving • and many other uses, both outdoors and indoors, for versatile steel grating

More EQUIPMENT NEWS

Begins on page 164

ing surfaces of both inner and outer links. This is claimed to eliminate need for surface lubrication, reduce coefficient of friction by 75% and decrease chain pull. Permanent, dry lubrication cuts maintenance costs, avoids lubricant drippage on conveyed parts and permits operation in temperatures ranging from –30 to 800 F.

U.S. Engineering Co, 14561 Lesure Ave, Detroit 27, Michigan

Electric chain hoist

650 • Electric chain hoist is available in capacities from ⅛ to 1 ton for operation on single phase 115 v and 3-phase 208-220/440 v, 60 cycle power.

Features claimed by manufacturer include: shock-proof push button control, sealed-in lifetime lubrication, self-adjusting heavy-duty brake, overload protection, compact size and low headroom. Unit can be used for extreme angle pulling. The single phase model (without contactor) can be used for side pulling.

Chisholm-Moore Hoist div, Columbus McKinnon Chain Corp, Tonawanda, New York

For more data on these items, use post cards p 173. Identify your request with item number.

Heavy-duty casters

640 • Four-position, plunger-type swivel lock is claimed to prevent accidental swivelling or rolling of casters supporting staging, scaffolding or heavy equipment. Caster wheels feature 2½-in. tread width. Caster's swivel lock positions are at 90 degree in-

Never leave dependability out of your fuel picture

A sailboat has no choice—it must depend upon an undependable wind for locomotion. Fortunately, you have a choice in fuels for your firing system. Select the fuel known for *complete* dependability—Bituminous coal! It's the one fuel which gives you:

Dependability of Supply—Bituminous coal provides, for centuries to come, an inexhaustible source of low-cost heat and energy. The vast Bituminous fields served by the B&O contain a great variety of outstanding coals for every purpose.

Dependability of Cost—Cost is kept low and stable thanks to the advancements made by modern mechanized mining. And coal is economical and safe to store.

Call on our Coal Technical Service! You will receive authoritative information on how to select the right Bituminous coal for your specific firing job . . . how to make the most of your fuel dollar. *Ask our man!*

Write: COAL TRAFFIC DEPARTMENT
BALTIMORE & OHIO RAILROAD
BALTIMORE 1, MARYLAND

BITUMINOUS COALS FOR EVERY PURPOSE

BALTIMORE & OHIO RAILROAD
Constantly *doing things*—better!

CYCLOTHERM CYCLONIC COMBUSTION

The most efficient method of combustion in steam generation!

Cyclotherm Steam and Hot Water Generators
15 to 500 hp
15 to 200 psi

Unequalled Heat Transfer Efficiency!

Cyclotherm Cyclonic Combustion guarantees a minimum 80% efficiency in oil and/or gas. Utilizes the largest possible heating area in the firetube. A flaming vortex spirals the length of the firetube. A thin layer of air prevents flame impingement . . . localized "hot spots" . . . and heat-retarding scale.

The Most Advanced Design!

Cyclotherm Cyclonic Combustion achieves its high heat transfer rate in only 2 passes. Permits a simplified design that reduces maintenance costs as much as 50%. Cyclotherm is as much as ⅓ smaller than other packaged units.

Completely Assembled On Arrival!

Factory-tested Cyclotherm costs less to ship because it's lighter in weight. Factory-insulation with fiberglas saves you up to $500 or $600. Installation requires only 5 connections. All parts necessary for safe, efficient, economical operation are supplied.

Automatic In Operation!

Electronic controls halt the Cyclotherm burner whenever operation is interrupted. A factory-pre-set water-level control automatically insures a sufficient supply of water always in the boiler. A low water cut-off control stops operation if the water supply is interrupted.

This free, information-packed booklet tells how Cyclotherm will help you achieve savings in time, costs and space. MAIL THIS COUPON TODAY!

YEARS AHEAD IN STEAM GENERATION
CYCLOTHERM®
Steam & Hot Water Generators

Cyclotherm Division, National-U.S. Radiator Corp.,
2522 E. First Street, Oswego, New York

Please send me your free booklet which shows me how I can save time, money and space with Cyclotherm.

NAME_____

COMPANY_____

ADDRESS_____

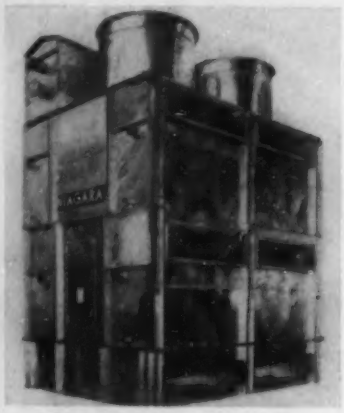
CITY_____ ZONE_____ STATE_____

More EQUIPMENT NEWS

Begins on page 164

crements. When unlocked, full 360 degree swivelling can take place. Lock feature is available on 6, 8 and 10-in. size units. Request bulletin S-54 for full information.

The Bassick Company, Bridgeport 2, Connecticut



Evaporative condenser

651 • Basic principle of 200-ton-refrigeration capacity unit is that of evaporating sprayed water from surface of condensing coils through which refrigerant gas passes, extracting heat at rate of 1000 Btu per lb of water evaporated. Air stream enters at top of condensing section, is drawn downward through water sprays, over condensing coils, then turns upward to leave unit through propeller-type fans at the top. This reverse direction air stream is said to increase capacity of unit and reduce outlay of electric power. Spray water falls into a tank at base of unit, from which it is recirculated. Further information on request to the manufacturer.

Niagara Blower Co, 405 Lexington Avenue, New York 17, New York

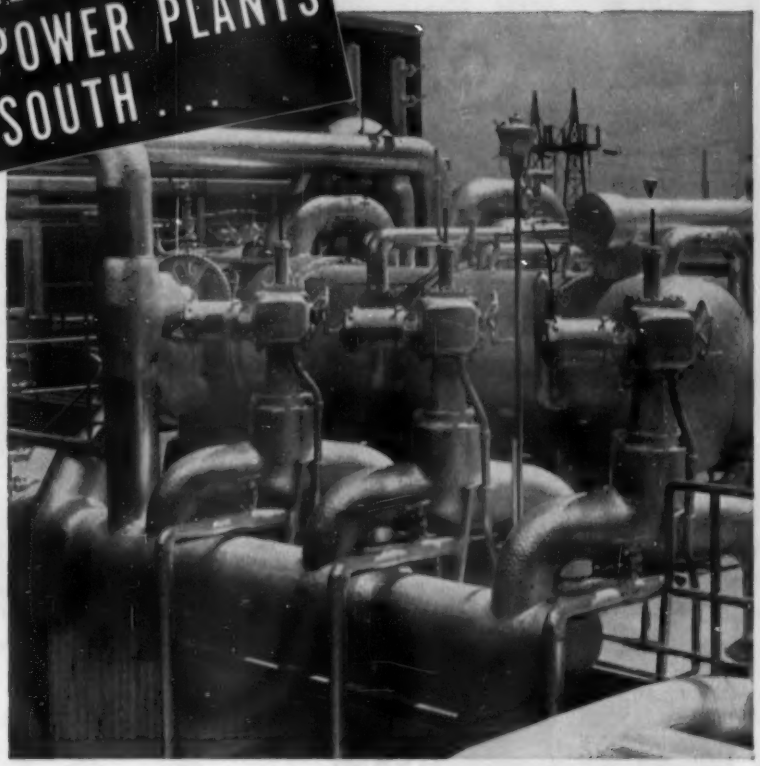
For more data on these items, use post cards p 173. Identify your request with item number.

Ball-bearing polyphase motors

626 • General-purpose polyphase motors are available in rerated NEMA frame sizes 182 through 326. Manufacturer states that cast iron frames are smoothly contoured so that moisture cannot collect on their surfaces. Construction is so completely drip-proof that the motors can be used for many applications formerly requiring splash-proof motors.

To protect motors from moisture, ventilating air intakes are located at bottom of endplates and air outlets are positioned at

One of the LARGEST and MOST MODERN POWER PLANTS in the MIDDLE SOUTH . . .



has installed Limitorque® VALVE CONTROLS on High Pressure STEAM LINES

Added to the long list of leading Central Stations and Private Power Plants which use "LimiTorque" Motorized Valve Operators, is the modern, new Delta Steam Plant of the Mississippi Power & Light Company located at Cleveland, Mississippi. This 200,000 kilowatt plant has installed many Walworth Valves with "LimiTorque" Operators on high pressure steam lines.

LimiTorque Remote Control permits one man to operate and know the status of each valve at a central push-button control station. This is an important safety factor, as men are not required to go to high, low or dangerous locations for manual operation. Further, LimiTorque automatically shuts off power should an obstruction occur in closing, thus protecting the valve parts. LimiTorque is always operative electrically, yet operating personnel are always positively safe, as the handwheel is automatically disengaged when the valve is motor operated.

LimiTorque operated valves are always seated tightly, because the seating thrust of valve disc is accurately maintained in each closing cycle through the patented torque limiting mechanism.

LimiTorque is available for all makes and types of valves, and is adaptable to existing equipment. Actuation can be by any available power source . . . electricity, water, gas, oil or air.

Send for complete Catalog L-54.

PHILADELPHIA GEAR WORKS, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.
LimiTorque Corporation - Phila.

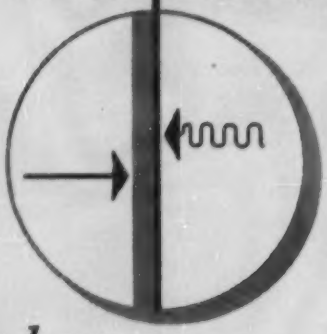
Industrial Gears & Speed Reducers

LimiTorque Valve Controls

Established 1892

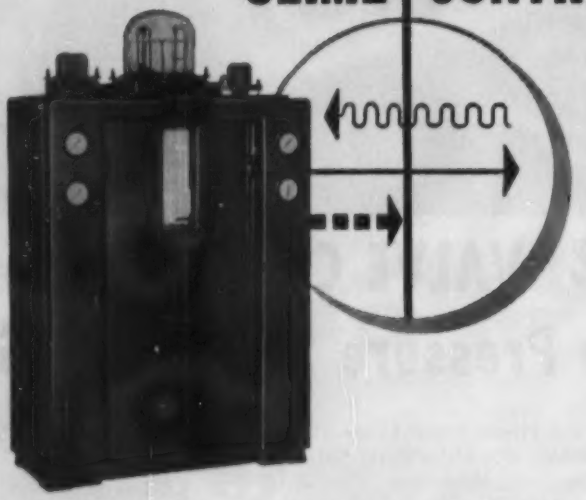
Where you need

HEAT | EXCHANGE



Be sure you have

SLIME | CONTROL



Whether you heat or cool water for make-up, process or any other use, you will need Wallace & Tiernan Chlorination to help combat slime problems introduced by water-borne bacteria or air-borne bacteria.

With slime control equipment designed for any need, built for lasting and dependable service, highly accurate and backed by over 40 years of successful application experience, Wallace & Tiernan Chlorination can help you increase the efficiency of your plant and cut operating costs. For further information write our Industrial Division.

WALLACE & TIERNAN

25 MAIN ST., BELLEVILLE 9, N. J.

CHLORINATORS • CHEMICAL FEEDERS • SCREENING EQUIPMENT • MAGNETIC SEPARATORS • PRECISION PRESSURE INSTRUMENTS • CATHODIC PROTECTION • FINE CHEMICALS

CD-39

More EQUIPMENT NEWS

Begins on page 164

base of frames on each side. Specially formed baffle plates direct air into blowers and through the motor. Rated at 1 to 30 hp, 3 phase, 60 cycles, 1750 rpm. Full details in bulletin MU-202.

Wagner Electric Corp, 6400 Plymouth Ave, St Louis 14, Mo.

Worm gear reducer

632 • Worm gear reducer is used for long, unsupported vertical output shaft extensions. It can be mounted on existing standard types of manufacturer's vertical gear units without major modifications to basic gear unit.

Wide bearing span is said to insure extreme rigidity for extended shaft, while "dry-well" construction eliminates necessity of stuffing box on the vertical shaft. Automatic reversing oil pump and filter, embodied within unit housing, insures lubrication of upper bearing on the vertical shaft. Request catalog W-48.

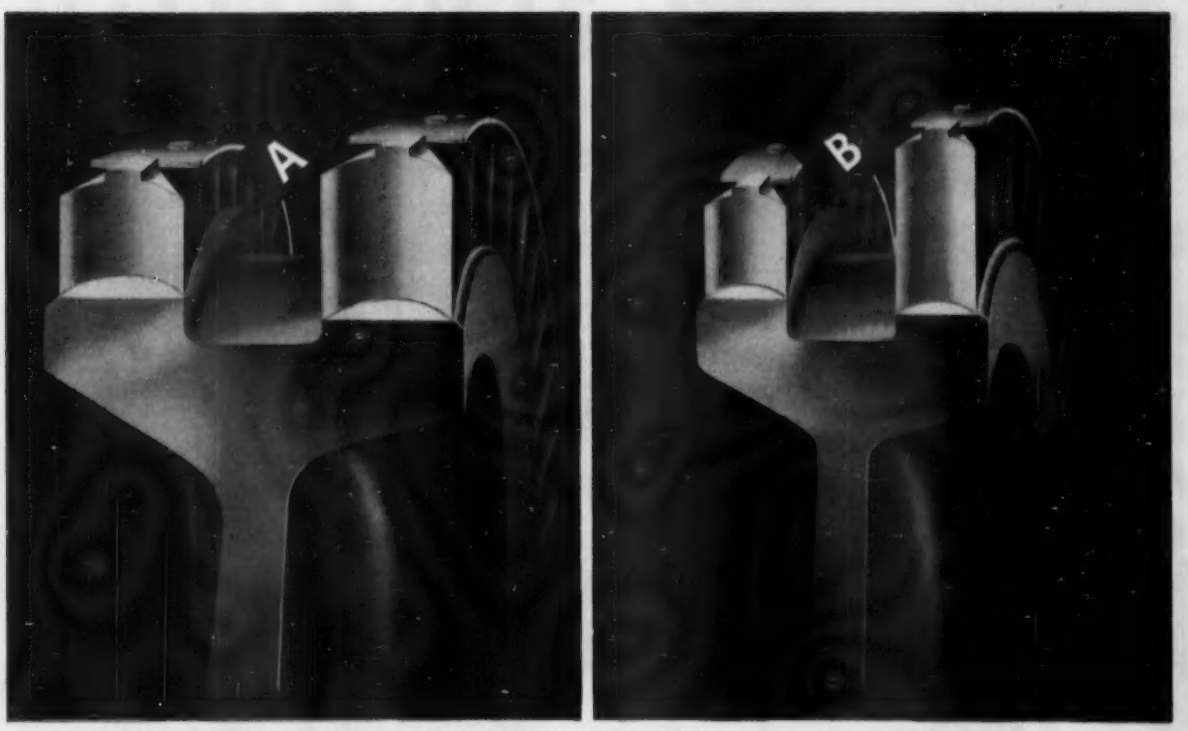
Philadelphia Gear Works, Erie Ave & G St, Philadelphia 34, Pa.

For more data on these items, use post cards p 173. Identify your request with item number.

Spring machinery mount

632 • Unit is designed for use where high absorption of vibration is necessary or where soft floors make control of vibration frequencies difficult. Available in 5 sizes, with 1, 2, 4, 6 or 9 springs, mounts have effective load range of 250 to 6700 lbs. Each unit has a built-in adjustment that permits leveling to ¾ in.

Simple damping adjustments can be made



(Left, A) wide bucket "L" type wheel. (Right, B) regular type wheel for Coppus Steam Turbines

Now...for low steam consumption – **COPPUS TURBINES** *can be furnished with wide bucket "L" type wheel*

Good news for steam turbine users where low steam consumption is important!

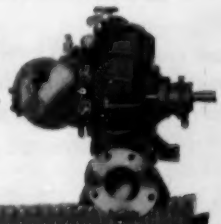
The Coppus Type "L" Wheel is the answer to this problem. Larger turbine buckets are employed to make the most economical use of steam.

In every respect the Coppus Turbine offers the top-quality features and advantages that have made the Coppus line outstanding for efficiency and economy. For example:

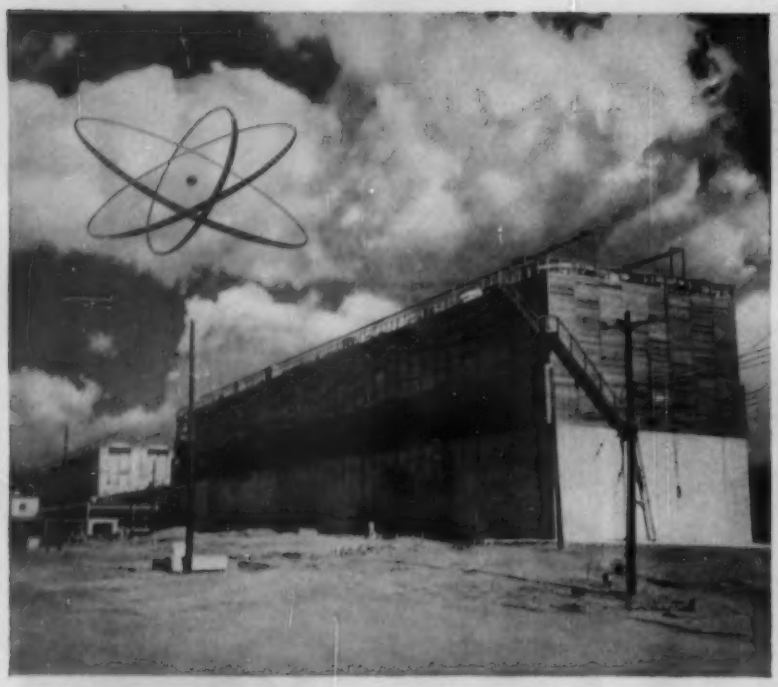
- Turbines rated close to your exact hp requirements, from 150 hp down to fractional. No need to buy a bigger, costlier turbine than your conditions call for.
- A larger number of steam nozzles, controlled individually by manually operated valves.
- Exclusive pilot operated excess speed safety trip supplementing constant speed governor.
- Replaceable cartridge type bearing housings.
- Optional carbon ring packing glands.

Coppus Steam Turbines ranging from 150 hp down to fractional, in 6 frame sizes, *make turbine dollars go farther.* Send for Bulletin 135 on Coppus Turbine.

COPPUS ENGINEERING CORPORATION
166 Park Avenue
Worcester 2, Mass.
Sales offices in
THOMAS' REGISTER



COPPUS "BLUE RIBBON" TURBINES



FW cooling tower
serves huge atomic plant

Now in service at a large Atomic Energy Commission plant, this 44-cell cooling tower designed and built by Foster Wheeler has a rated capacity of more than 150,000 gallons per minute. Covering an area of approximately 46,500 square feet, it is one of the largest cooling tower installations ever made.

Foster Wheeler cooling towers reflect more than 50 years of experience in meeting the specific requirements of all types of power and process plants. Each tower is engineered and constructed to give maximum performance at minimum cost.

For complete information on FW cooling towers, send for your complimentary copy of Catalog CT-52-4. *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

FOSTER WHEELER

More EQUIPMENT NEWS

Begins on page 164

to check excessive machine motion or bounce. Dampers are faced with friction brake linings, acting on the steel surfaces, that dampen horizontal as well as vertical forces. Details on request.

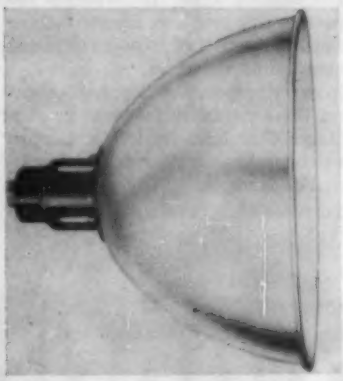
Barry Corp, Watertown, Mass.

High volume steam cleaners

639 • Compact steam cleaners, gas or oil fired, feature capacities of 300 to 3000 gph. Unit's heat exchanger raises water temperature to 100 F before water enters the main circuit. This is accomplished by trapping waste heat, thus reducing fuel consumption. Automotive-type piston pump runs in oil and has stainless steel ball check valves to provide high volume output. Strength of cleaning solution is automatically maintained at the desired pH. Request bulletin 136 for full details.

Kelite Products, Inc, 1250 N Main St, Los Angeles 12, Calif.

For more data on these items, use post cards p 173. Identify your request with item number.

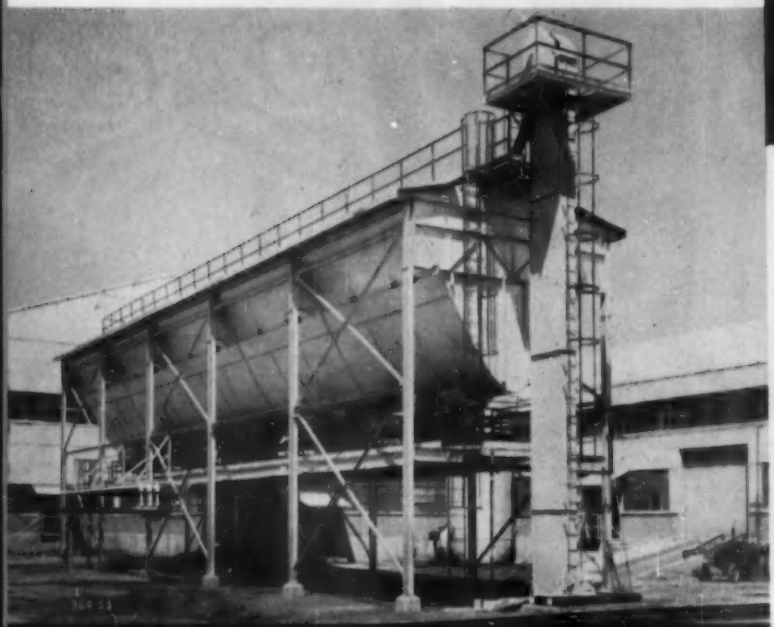


Aluminum light reflector

653 • Aluminum reflector has a hard anodic treated surface, said to resist discoloring and tarnishing. Slotted neck ventilation induces an updraft, manufacturer states, allowing heat generated by lamps to be quickly dissipated in outside air, and airborne dust and dirt to be carried through

JEFFREY GETS COAL TO WORK ON TIME!

Electrical power is generated at this plant. A Jeffrey belt conveyor performs the important job of bringing coal from storage piles to coal bunkers.



Fiberboard products are this company's business. A Jeffrey bucket elevator, lifting coal to storage, is an important step in this manufacturing process.

Hotel hospitality on a grand scale goes on while in the basement a Jeffrey pivoted bucket carrier forms complete run-around system handling coal or ashes.

At a busy manufacturing operation . . . in an important electric generating plant . . . beneath one of the largest hotels in the world — Jeffrey handling equipment gets coal to work on time and keeps it coming.

Jam-ups in coal inflow or ash removal close down power plants pronto, whether they need a few tons, or several thousand tons per hour. Machinery stops, lights go out, guests grumble.

That's why Jeffrey talks first of dependability. Place your confidence in Jeffrey to keep coal rolling without a halt — efficiently, economically.

No matter what handling unit or system you need, chances are Jeffrey has engineered, built and installed one just like it. Jeffrey's vast experience is backed by the highest standards of design, materials and workmanship.

If your coal comes to work late, loafs on the job, suffers from bad handling on obsolete equipment — better see Jeffrey! We'll be glad to send you Catalog 778-A describing complete power plant equipment — weigh larries, vibrating, apron and plate feeders; crushers; trippers; spiral and scraper conveyors; drag chains; skip hoists; car pullers; bin accessories, etc.

Write for Catalog 778-A.

THE JEFFREY MANUFACTURING CO.

ESTABLISHED 1877

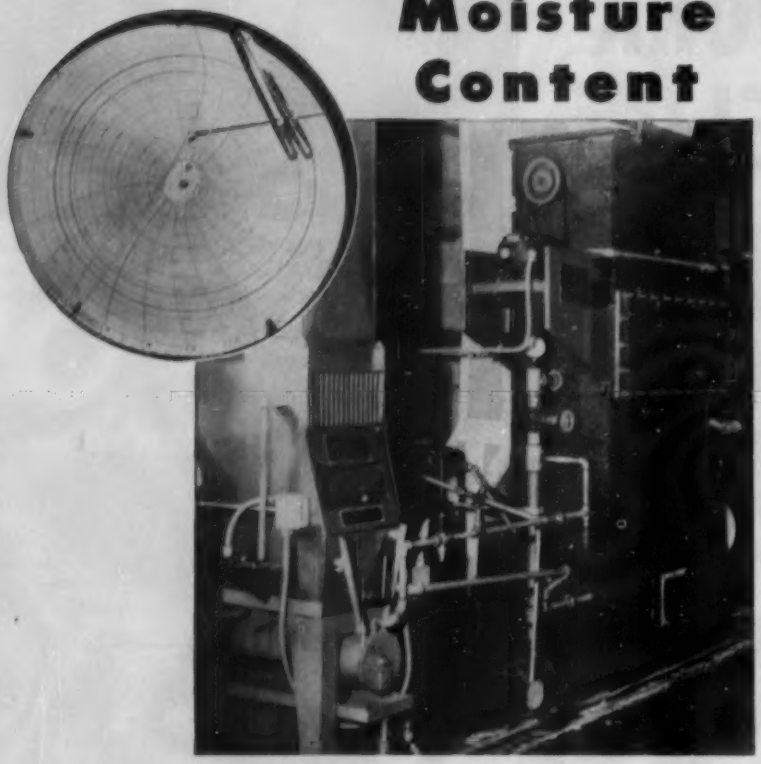
Columbus 16, Ohio

sales offices and distributors in principal cities

PLANTS IN CANADA, ENGLAND, SOUTH AFRICA

IF IT'S MINED, PROCESSED OR MOVED . . . IT'S A JOB FOR JEFFREY!

EXACT CONTROL of Moisture Content



. . . To Improve Your Product or Protect Your Materials or for Processes or Tests

● This Niagara Air Conditioning Method dries air directly and measurably, using a moisture-absorbing liquid spray. It makes humidity control a separate function from lowering or raising temperatures and gives you precise control with thermostats alone; no moisture-sensitive devices are needed. You have simpler, more trustworthy, less expensive control instrumentation. Niagara precise-control installations have the best record for reliability.

Niagara Air Conditioning provides you with any temperature and relative humidity you need. Using "Hygrol" absorbent, it is not expensive to operate, saving the refrigeration commonly used to condense moisture and making re-heat unnecessary in most cases. It gives large capacity with compact, easily-maintained equipment. Ask for Descriptive Bulletins #112 and #121.

Address Dept. P.

NIAGARA BLOWER COMPANY

405 Lexington Ave. New York 17, N.Y.

District Engineers in Principal Cities of U. S. and Canada

More EQUIPMENT NEWS

Begins on page 164

reflector instead of accumulating on inside suface. Unit may be used with 400-w mercury vapor lamps or for incandescent lamps of 750/1000/1500 w. Available in socket-reflector or separable socket styles.

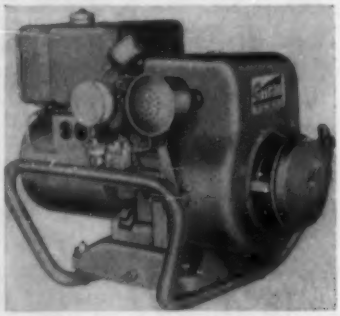
Jones Metal Products Co, West Lafayette, Ohio

Explosion-proof floodlight

642 • Explosion-proof floodlight is designed for a wide variety of uses in Class I, Groups C and D hazardous locations. They are of aluminum construction making them weather resistant, light and portable. The plain, heat resistant front glass is clamped into position by means of an internal ring and is easily removed to facilitate lamping.

The Pyle-National Co, 1340 N Kostner Ave, Chicago 51, Ill.

For more data on these items, use post cards p 173. Identify your request with item number.



Electric generating plants

654 • Engine-driven units are available in sizes of 500 and 750 w, 60-cycle, ac for the *AK Series* and in 1000 and 2500 w, 60-cycle, ac in the *AJ Series*. Battery charging units are available in sizes from 500 to 1500 w, dc.

Powered by air-cooled, 4-cycle, single-cylinder gasoline engines, *AK* models deliver 1.85 hp at 1800 rpm; *AJ* models, 2.75 hp at 1800 rpm and 5 hp at 3600 rpm.

Because of their small size and high out-

(*Continued on page* 194)

Armaflex . . . *flexible plastic pipe insulation that's fast and easy to apply*

This new, foamed plastic pipe insulation has been developed especially for formed copper tubing and other types of piping that are difficult to insulate. Light in weight, Armstrong Armaflex* is so flexible it can be slipped right on pipes or tubing when they're being installed.

If the lines are already in operation, Armaflex can be slit longitudinally, snapped on the pipe, and sealed with Armstrong No. 520 Adhesive.

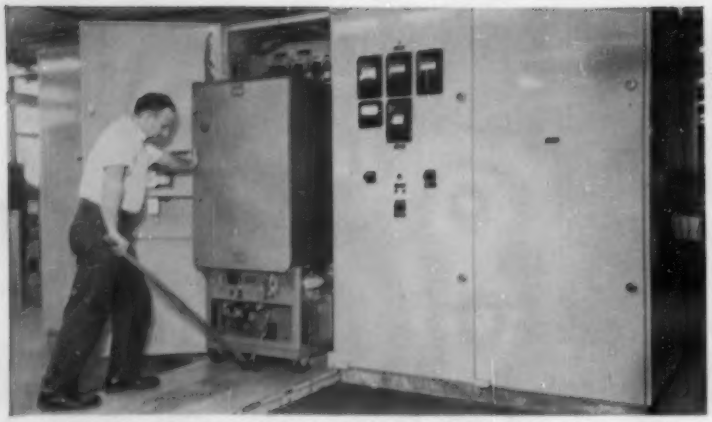
Armstrong Armaflex combines low cost with high efficiency. It will withstand temperatures from 32° F. to 200° F. Its foamed plastic composition is made up of uniformly sized, closed cells that make it air tight and waterproof. No vapor barrier is needed. Armaflex is manufactured with inside diameters of ⅝", ⅜", 1⅛", and 1⅜". Because of its flexibility and resilience, it will fit pipe and tubing with the same or closely corresponding outside diameters.

Armaflex is one of the many new products developed by Armstrong Research to help solve your high- and low-temperature insulation problems. **For free booklets,** with full details on Armaflex as well as the entire line of Armstrong Industrial Insulations and complete Contract Service, call your nearest Armstrong Office or write Armstrong Cork Company, 208 Stratton St., Lancaster, Pa.

*Trade-Mark

Installation is easy. Simply slip Armaflex over straight or bent tubing or pipes. Being flexible, it goes on easily over sweated couplings.

Armstrong INDUSTRIAL INSULATIONS

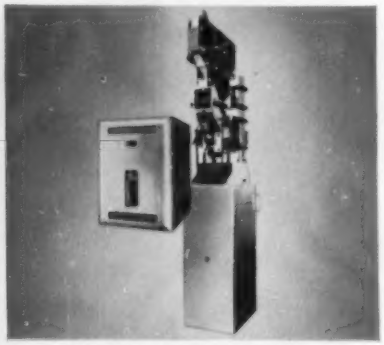


Metal-clad switchgear. Horizontal drawout air circuit breakers in rigid, all-welded enclosures. Available in ratings from 2400 v through 15 kv—50 through 500 mva interrupting and 2000 amp continuous.

Nonsegregated phase, metal-enclosed bus. For switchgear connections. In ratings 600 v through 6000 amp; 5, 7.5 or 15 kv through 5000 amp.

Unit substations. I-T-E primary and secondary unit substations can be supplied for any application—indoor and outdoor—and in any standard rating.

Low voltage switchgear. Ratings through 600 v a-c, 250 v d-c, 6000 amp continuous, 15,000 through 150,000 amp interrupting.



Individual breakers. I-T-E large air circuit breakers are available in a wide range of types and ratings, 600 v a-c, 250 v d-c, 750 v d-c.

NEW CONSTRUCTION ECONOMY TIP: BUY AN I-T-E "POWER PACKAGE"

Coordinated engineering, delivery and installation means a better investment

An I-T-E "power package" includes the complete power handling facilities you need for a new construction project, building addition, or simple expansion of electrical service—one unit or a complete system for application from generation to end use. You save many ways:

Sound planning. Talk with your local I-T-E application engineer about your general power requirements before you build. He'll work with you to determine the equipment needed to assure complete protection with greatest economy in total investment, operating costs, and construction time.

Easier installation. Before you begin construction, I-T-E will supply you with arrangement and channel base drawings. Equipment is factory assembled, tested and ready to install. Standardized frames and panel elements assure that future additions to your switchboard will match and line up.

Coordinated delivery. Shipments are made from I-T-E according to a predetermined schedule. Each part of the complete "power package" is delivered to the job when needed. This saves delays and eliminates inconveniences.

Assured performance. Since I-T-E will supply all equipment—pre-engineered—you are saved the work of coordinating equipment of different manufacture. You can be sure that the separate parts of an I-T-E "power package" will fit and function together.

For details, contact the I-T-E sales office nearest you—look in your classified directory under "Electric Equipment." I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Philadelphia 30, Pa.

I-T-E

I-T-E CIRCUIT BREAKER COMPANY
Switchgear Division

West Penn Power Company selected Gulfcrest Oil to lubricate this 140,000 kilowatt unit on the basis of its outstanding performance in the other turbines at their Springdale, Pennsylvania Plant.

—they looked at the record and again selected

GULFCREST OIL

When the West Penn Power Company looked at the record of Gulfcrest Oil in its seven turbine units at Springdale, the choice of lubricant for Number Eight was no problem—Gulfcrest again!

Here's what the record showed: In each of the seven units the original fill of Gulfcrest had been in service for years without any significant changes in its characteristics. And of course the turbines operated continuously and dependably during this period.

A record like this did not just happen. It is the result of careful selection of crude oils that are thoroughly refined, then super-refined by Gulf's exclusive Alchlor Process, which removes the unstable hydrocarbons that remain after normal refining. This discarded portion, if allowed to remain in a turbine oil, accelerates oxidation, increases neutralization number, forms sludge, and harmful acids.

So to insure safe, long-lasting protection for your turbines, specify Gulfcrest—the world's finest turbine oil. Contact your nearest Gulf office today and have a Gulf Sales Engineer recommend the proper grade.

GULF

THE FINEST PETROLEUM PRODUCTS FOR ALL YOUR NEEDS

GULF OIL CORPORATION • GULF REFINING COMPANY

1822 GULF BUILDING, PITTSBURGH 30, PA.

NATIONAL AIROIL

OIL BURNERS

of the steam and mechanical types now combined into

DUAL STAGE BURNERS

PATENT PENDING

Now, at last, the inherent advantages of *both* systems of fuel oil atomization are *profitably* yours . . . within the one, new NATIONAL AIROIL Dual Stage Burner.

42 years of combustion equipment design and manufacture are in back of the Dual Stage Oil Burner . . . and, it has been thoroughly tested and proved in the field for firing: Petroleum Processing Heaters; Rotary Kilns; H.R.T., Scotch Marine and Water Tube Boilers; etc.

Available in three sizes, the NATIONAL AIROIL Dual Stage Burner fires all grades of fuel from No. 2 to No. 6, with a ready capacity of 80 to 300 g.p.h. Further, for a perfect flame pattern, we would recommend using with the Dual Stage Burner either the NATIONAL AIROIL Universal Register for forced draft or, the NATIONAL AIROIL Tandem Unit for natural or induced draft furnaces.

Get detailed description, illustration, and specifications in NATIONAL AIROIL Bulletin 25.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
STEAM ATOMIZING OIL BURNERS
SLUDGE BURNERS, Steam Atomizing
MOTOR-DRIVEN ROTARY OIL BURNERS
MECHANICAL PRESSURE ATOMIZING OIL BURNERS
DUAL STAGE, Combining Steam and Mechanical Atomization
LOW AIR PRESSURE OIL BURNERS
AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
GAS BURNERS
COMBINATION GAS & OIL BURNERS
FUEL OIL PUMPING and HEATING UNITS
FURNACE RELIEF DOORS
OBSERVATION PORTS
SPECIAL REFRACTORY SHAPES

NATIONAL AIROIL BURNER CO., INC.

1230 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.
Southwestern Division: 2512 South Boulevard, Houston 6, Texas
INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

More EQUIPMENT NEWS

Begins on page 164

put per pound weight, these units are highly suitable for mobile and portable applications. Full details on request.

D W Onan & Sons, Inc,
Minneapolis 14, Minnesota

10-lb fire extinguisher

638 • Dry chemical fire extinguisher carries UL approval for a pressure range of 150 to 250 lbs. Unit features a pistol-grip trigger release mechanism, and a dust and moisture-proof gage that shows unit's charged pressure. In securing UL approval unit extinguished 40 sq ft gasoline fires when operated at both the lower pressure of 150 lbs and through a 100 lb range up to 250 lbs, manufacturer states.

Walter Kidde & Company, Inc,
Belleville, New Jersey

For more data on these items, use post cards p 173. Identify your request with item number.

Thermo-closing drum cover

631 • By tightening wing nut of the band attached to drum cover any used 30 or 55-gallon steel drum or standard corrugated

For a wide range of uses

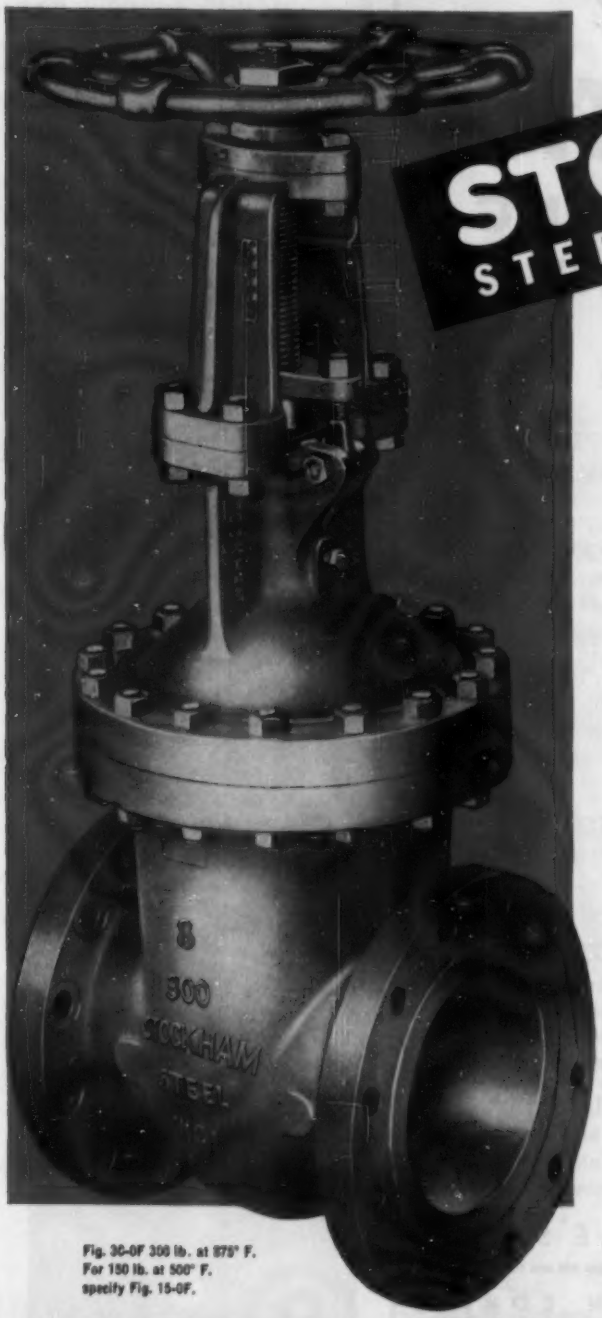


Fig. 30-GF 300 lb. at 875° F.
For 150 lb. at 500° F.
specify Fig. 15-GF.

STOCKHAM STEEL GATE VALVES

are rugged

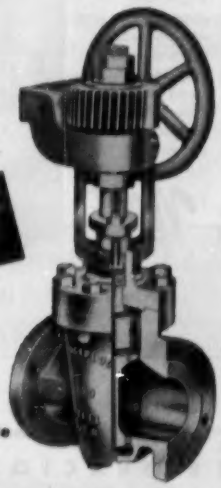
Although rated at 150 pounds at 500°F. and 300 pounds at 875°F., these valves give high performance under a wide range of temperatures and pressures. Many trim combinations can be furnished to meet the service requirements of water, steam, oil, chemicals, gas and vapors under normal, corrosive, erosive and oxidative conditions. With straight through port design, there are no pockets to cause turbulence. These valves allow maximum flow, with minimum friction and pressure loss.

VALVES:
Bronze • Steel • Iron Body

FITTINGS:
Cast Iron Screwed, Flanged
Cast Iron Drainage
Malleable Fittings & Unions

Ask about

WEDGEPLUG
NON-LUBRICATED
STEEL PLUG VALVES



WEDGEPLUG VALVE COMPANY, INC.
NEW ORLEANS, LA.
A Stockham Valves & Fittings Affiliate

STOCKHAM VALVES & FITTINGS

GENERAL OFFICES AND PLANT • BIRMINGHAM 2, ALABAMA
Warehouse Stocks and Sales Services Strategically Located
DISTRIBUTED THROUGH WHOLESALERS

STICKS TIGHT ALL RIGHT TO ANY SURFACE...

and

STIC-TITE INSULATING CEMENT

Does Much More

A granular mineral fibre and diatomaceous earth mixture; requires only clean water to make plastic, easy-to-work cement.

Now 55 Million Pounds in Heat Saving Service

EASY TO APPLY
On any hot or cold surface—flat, round or irregular shapes and fittings up to 1800° F. Grabs and holds tight. Quickly troweled smooth. Dries out air-tight and seamless, when used as a finish.

COVERS BETTER
At least 45 sq. ft. 1" thick per 100 lbs. of Stic-Tite. That's double the coverage of asbestos cement. Needs no reinforcement up to 1½" thick.

LOOKS BETTER
Has attractive appearance—not dingy or gray. Can be sized, painted or waterproofed.

LASTS LONGER
Sticks tight—yes, and resilient, too. Does not lift off or shake loose under normal plant vibration, impact or abrasion.

MORE EFFICIENT
Stic-Tite has the highest insulating efficiency of all plastic insulations, double that of asbestos cement.

Test Stic-Tite Yourself—Get FREE Sample

REFRACTORY & INSULATION CORP.
132 WALL STREET • NEW YORK 5, N. Y.

Send me a sample bag of Stic-Tite and bulletin

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

More EQUIPMENT NEWS

Begins on page 164

trash can is made into a fire preventitive container. Cover makes unit a safe receptacle for oily rags, paints, solvents, packing materials and similar combustibles. Hinge of drum cover has a spring plunger that attaches cover to the steel strap. Strap is fastened to top portion of drum. Normally cover stands open for convenient receiving of refuge. It is held in position by the spring plunger unit that contains a low melting point fusible link. Should fire start, fusible link melts, releasing spring plunger. Cover is closed and fire within the drum is snuffed out. Surrounding fire will also actuate the link and close the cover. Fusible links can be easily replaced.

The Protectoseal Co, 1920 S Western Ave, Chicago 8, Ill.

4-way solenoid valve

636 • Poppet-type, 4-way solenoid valve is said to eliminate piston malfunction due to binding or residual magnetism. It is designed to provide greater safety, minimized leakage and cycling rates to 850 per minute. Unit is power operated in both directions. Spring action has been eliminated entirely. Valve is available as either a single or dual solenoid, depending upon electrical circuit involved. Dual solenoid valve has additional safety advantage of locking into position on power failure, manufacturer states.

Unit is designed to operate in any position and on all standard voltages. Power consumption is 10 watts. Dual solenoid valve is built to withstand pressures to 500 psi, single solenoid to 250 psi.

Automatic Switch Company, 391 Lakeside Ave, Orange, N. J.

For details on these items use post cards p. 173. Identify request with item number.

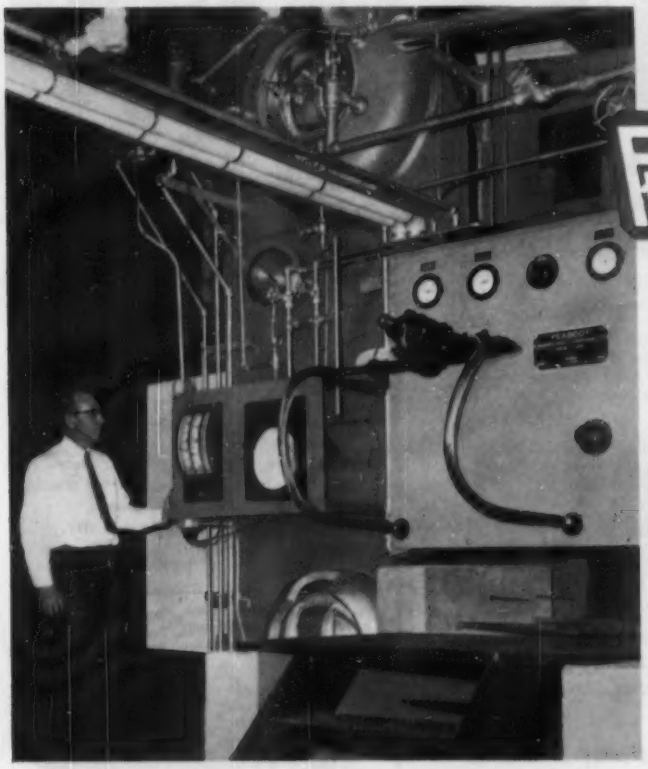
Rubber expansion joints

635 • These expansion joints are made of high-grade rubber compound combined with plies of cotton duck and reinforced with steel wire. Installed in pipe lines, they com-

HOTEL SYRACUSE

SYRACUSE, NEW YORK

CUTS STEAM COSTS by $13,680 per year



Chief Engineer John Reschke of Hotel Syracuse makes routine inspection of new FW Packaged Steam Generator. This single unit, in continuous year-around service, supplies all steam requirements for the Hotel's 600 rooms, 4 restaurants, 3 kitchens, 13 stores, lobby, grand ballroom and laundry PLUS the heating and processing requirements of an adjacent hotel!

with this new

packaged steam generator

Central New York's largest hostelry, the 600-room Hotel Syracuse, recently replaced two of their original coal-burning boilers with a Foster Wheeler 25,000 lb/hr Packaged Steam Generator.

According to Chief Engineer John Reschke, the advantages of the new unit were immediately apparent. Steam cost dropped from 90 cents to 71 cents per 1,000 lb. Based on average consumption of about 72,000,000 lb per year, this represents an annual saving of $13,680 in steam costs alone. Other advantages are rapid steaming, lower maintenance and a cooler boiler room.

• • •

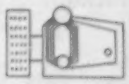
For low-cost steam "where you need it — when you need it," you get a better buy with the Foster Wheeler Package Steam Generator. For more detailed information, write for *new* catalog, PG-55-3. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

LOOK INTO THESE FW FEATURES:

RAPID LOAD SWINGS. Large diameter drums and ample heating surface.

HIGH STEAM TEMPERATURES. Provisions for high superheat.

ADAPTABILITY. Easily moved. Require only a slab foundation—permit outdoor installation.



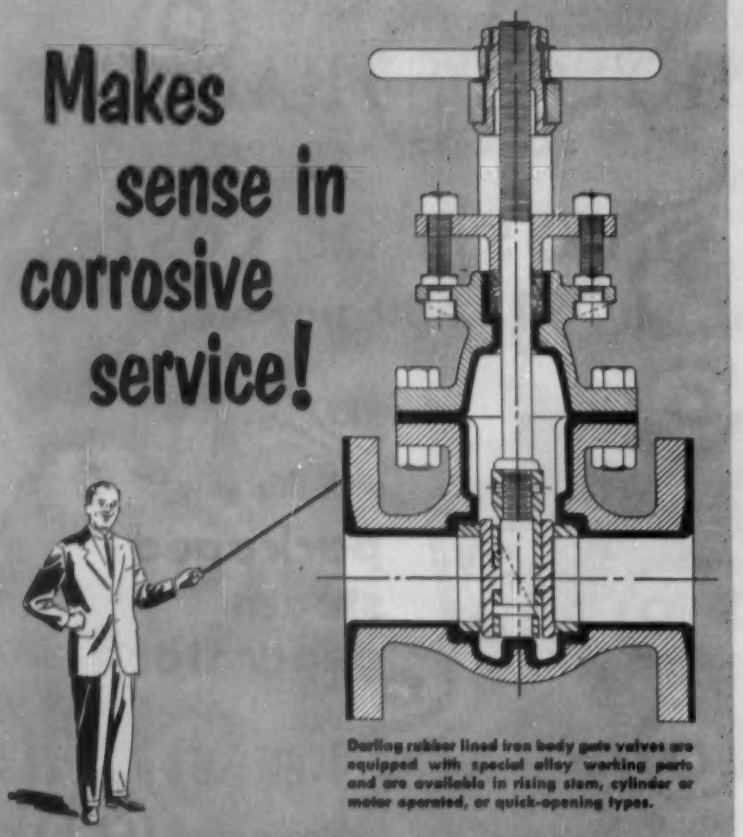
ECONOMIZERS. Package economizers available to increase capacity and minimize fuel cost.

ACCESSIBILITY. For inspection, cleaning and maintenance.

COOLER OPERATION. Maximum water-cooled surface, special insulation mean cooler boiler room.

FOSTER WHEELER

Makes sense in corrosive service!



Darling rubber lined iron body gate valves are equipped with special alloy working parts and are available in rising stem, cylinder or motor operated, or quick-opening types.

DARLING RUBBER LINED IRON BODY GATE VALVES

Problem: How to get away from costly, special alloy gate valves in handling corrosive fluids and still have long, trouble-free valve life.

Answer: For pressures up to 150 pounds and temperatures to 180° use Darling iron body gate valves with the permanently bonded hard rubber lining. They're giving outstanding service in job after job. Moreover, they have the Darling *fully revolving double disc parallel seat feature* that multiplies disc and seat life and assures tight closure longer . . . much longer!

Write for complete information on these exceptional rubber lined valves . . . or for data on other Darling gate valves including the range of alloys, types and constructions for ordinary or special services.

DARLING VALVE & MANUFACTURING CO.
Williamsport 8, Pa.
Manufactured in Canada by
Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.

More EQUIPMENT NEWS

Begins on page 164

pensate for linear expansion and contraction of line due to temperature changes, absorb vibration that is destructive to mechanical equipment, reduce or eliminate transmission of undesirable noise, and compensate for misalignment in piping.

Steel rings are incorporated in the flange ends to permit tightening without shearing. They are furnished for pipe sizes from 1 to 12-in. Request bulletin AD-137.

The Garlock Packing Co,
Palmyra, New York

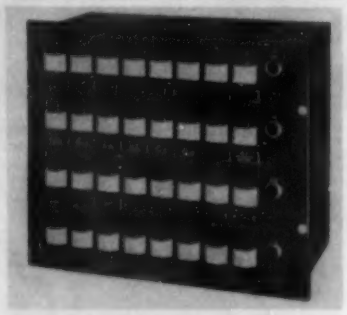
Combination test instrument

622 • Self-contained tester is designed for checking millivolt output of thermocouples in both opent and closed circuits, from 0-50 and 0-1000. It is suited for testing single or multiple thermocouple installations.

Instrument will also accurately check temperatures, within range from "room" to 650 F, of water heaters, ovens, heat treating installations, etc. Data on request.

Robertshaw Thermostat div,
Robertshaw-Fulton Controls Co,
Youngwood, Pennsylvania

For more data on these items, use post cards p 173. Identify your request with item number.



Multifunction alarm system

636 • Versatile annunciator system is said to perform a 3-fold function. (1) It alerts any off-normal condition in the manufacturing process by means of visual and audible alarm, (2) it gives indication of the first failure in a sequential operation, and (3) it automatically selects and monitors the correlated safety auxiliary shut-down equipment.

Standard unitized components are used throughout. Plug-type hermetically sealed

County Courthouse, Newkirk, Oklahoma

Where does the Court get its power?

For seven years in Newkirk, Oklahoma, one powerful machine controlled the power of the court... a Fulton 800 H.P. dual-fuel generating unit, lubricated by Cities Service Pacemaker #5 Oil.

But it wasn't only the court that depended upon this one machine . . . the entire town relied upon it. If the machine failed, so might the annual grain harvest, for Newkirk's grain elevators require great quantities of power.

BUT THE FULTON GENERATING UNIT AND CITIES SERVICE LUBRICATION PROVIDED FAULTLESS SERVICE. There was never a breakdown.

Newkirk's power boss, Superintendent of Utilities Ralph E. Cottrell, sums it up this way: "Using Pacemaker #5 in the engine's crankcase and cylinder lubricators, we not only enjoyed trouble-free operation during those seven years, but also surprisingly little wear and oil consumption. Rings, bearings and liners remained in top notch condition and the engine piled up well in excess of 6000 horsepower hours per gallon of oil."

This is but one more powerful story of Cities Service Lubrication . . . a graphic illustration of the kind of results you can expect from these highest quality lubricants. Why not get the whole story from a Cities Service Lubrication Engineer? Or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

Ralph E. Cottrell, Power Boss of Newkirk, Oklahoma. All of Newkirk depends on him as Supt. of Utilities. He depends on Cities Service Lubricants for town's power generators.

Powerful Machine Behind The Court is this Fulton 800 H.P. dual-fuel generating unit. For seven years Newkirk's only major power source, it gave "faultless performance" using Cities Service Lubricants.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

Open Drip-Proof

Explosion-Proof

(Behrage) Variable Speed

Type C-Face Mounted

Sadivar Variable Speed Motor

NEMA standards, plus!

APPLICATION-PROVED PERFORMANCE-TESTED!

With All These Features — And More!

PRECISION STATOR CONSTRUCTION
HIGH-DIELECTRIC INSULATION
ANTI-FRICTION BALL BEARINGS
ACCESSIBLE TERMINALS
SKEWED ROTOR LAMINATIONS
DYNAMICALLY BALANCED ROTOR
CONTROLLED, FORCED VENTILATION
SIMPLE, RUGGED CONSTRUCTION

Coordinated design, manufacturing, and service engineering dedicated to producing the finest motors for industry, at pass-along savings made possible by the most modern manufacturing facilities. ACEC motors are your best buy today! You get quality based on the principle that *every part is critical* — You save money in original cost — and in less maintenance, decreased downtime, and deferred replacements. Write for our new bulletin on any of the following motors: O.D.P. — T.E.F.C. — V.H.S. — Explosion-Proof — Gear — Wound Rotor — Synchronous — Variable Speed.

For information on how you can save with ACEC, write or call:

ACEC

ELECTRIC CORP.

40 E. 49th St., New York 17, N. Y.

OFFICES IN PRINCIPAL CITIES

More EQUIPMENT NEWS

Begins on page 164

relay units are used for illuminating the 2-color turret lenses and for performing all the functions of the system.

Industrial Automation Co, 2415 W Montrose Ave, Chicago, Ill.

Multi-point indicators

623 • System permits taking nearly simultaneous temperature readings at several points on a single, centrally located pyrometer. System consists of several thermocouples, each at different locations (furnace, kiln, bearings, etc.) and connected to a high resistance pyrometer equipped with a selector switch. Pyrometer, selector switch and terminal strip are all enclosed in a single cabinet. Calibrating spool of wire may also be installed in cabinet if needed to compensate for widely varying distance to thermocouples. Request bulletin IN-1 for further information.

West Instrument Corporation, 525 N Noble St, Chicago 22, Ill.

For more data on these items, use post cards p 173. Identify your request with item number.

Isolated phase bus

637 • Isolated phase bus is desined for all current ratings to 10,000 amps and voltages to 34.5 kv. New design eliminates all longitudinal gaskets, supporting ring gaskets and cover bolts. Telescoping covers permit easy inspection by removing two nuts that lock clamping rings in position. Sliding a retaining ring and ring gasket, the cylindrical inspection cover can be moved out of the way. This opens a 2½-ft section for inspection of conductors, splices and supporting insulators.

When cover is closed adjustable toggle clamps with compression springs maintain pressure. Circular gaskets at these points are fully trapped and self-seating, sealing out moisture and dust.

Longitudinal sections 6 to 8-ft long can be pre-assembled and shipped in lengths as large as customer's facilities can handle. Further details available on request.

Delta-Star Electric div, H K Porter Co, Inc, 342 Madison Avenue, New York 17, New York

Get low-cost boiler feed from oil-bearing condensate...

WITH SORBO-CEL FILTRATION

Sorbo-Cel filtration systems are compact . . . easy to operate with unskilled labor.

2¢—5¢ per 1000 gallons is all it costs you to reclaim oil-contaminated condensate with Sorbo-Cel® filtration. Sorbo-Cel can reduce oil content to less than 0.1 ppm . . . also removes rust, scale and other suspended solids. Sorbo-Cel not only saves water, but materially reduces boiler tube maintenance caused by oil and suspended solids in the feed water. And proper lubrication need not be sacrificed to insure oil-free water.

Sorbo-Cel is a diatomite powder specially processed to provide the most efficient and economical filtration of oil-contaminated water . . . for boiler feed or other process applications. It can be used with practically every type of pressure filter and requires no additional chemicals.

Free! Information and Engineering Service. Write today for your free copy of the new Sorbo-Cel brochure. If you desire, a Sorbo-Cel engineer will call for appointment to visit your plant. Address Johns-Manville, Box 60, New York 16, N.Y. In Canada, Port Credit, Ontario.

JM Johns-Manville SORBO-CEL®

PROMPT ROTOJET TUBE CLEANER SERVICE

Prevents costly delays

It is a tribute to the durability of ROTOJET Tube Cleaners that so many of them outlive the equipment for which they were bought. Why wait until your tube cleaners wear beyond repair when an inexpensive adjustment or parts replacement can put them into first class condition again?

Do This Now—

Examine your motors, hose, and couplings, and check your stock of heads and brushes. Let our trained mechanics make any necessary adjustments. Do it now, and they'll be ready when you need them.

For Prompt Service and Delivery

YOUR BEST BET IS

ROTOJET®

ELLIOTT COMPANY-ROTO DIVISION

153 Sussex Ave. • Newark, N. J.

MARMADUKE

Continued from page 152

That did it. The place quieted down, and I grabbed a seat and got busy with my notebook and pencil.

"The *Grant* was a new Shipping Board freighter, built during the last months of the war," bellowed Marmy as he leaned on the bar. "She was turned over to our line for peacetime service, straight from the shipyard. So she had plenty of bugs to work out of her system for the first few trips. But I learned a long time ago that all the bugs aren't in the engine room, and it proved to be true on that ship.

"The *Grant's* three watertube boilers supplied 240-psi steam to her 6350-hp cross-compound turbine. Her main shaft was driven through reduction gearing. She was a neat ship, but I had plenty of tough nuts to crack, not only down below, but all over the vessel too.

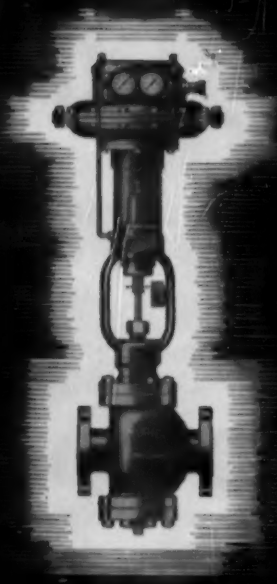
"We signed on a crew before shoving off from Hunter's Point shipyard in San Francisco Bay. One character was Tony, the cook. Tony was a good-natured Italian who had been a galley mechanic on Italian and French ships. He liked everyone. He liked to eat, he liked to cook and he liked to see that everyone ate well. He took pleasure in getting plenty of chow on the table and personally made sure the Chinese mess boys got it to us in good shape. Tony had been standing up to galley ranges for so long that he had galley feet. That's when one foot points to north, northwest, while the other points to east, southeast—the two of them scribing an arc of 143 degrees.

"One evening, halfway across the Pacific, Tony stuck his head into the officers' saloon and announced he was serving his favorite minestrone soup next day. 'Whena I maka da minestrone, she's so good you eat so much you bust,' he promised, shaking with laughter.

"Next day Tony got busy with his peas, spaghetti and other odds and ends and cooked his soup in the large stockpot on the galley range. He was old-fashioned and wouldn't use the new double-jacketed steam kettle. Said that was only for keeping the soup warm once it was made. So he dumped the soup into the kettle and opened the steam valve to keep it warm until lunch time.

"By noon Tony had been all over the ship, beating the drums for his minestrone soup. When the mess boy ordered the first plate of soup, Tony's face lighted up. He removed the kettle's cover quickly—then let out a moan.

"All but a few quarts of the soup was gone. 'Soma wisa guy he play joke, hey?' raved Tony, getting up a



FISHER® WIZARD - - - *UNIVERSALLY ACCEPTED AS THE WORK HORSE ON SIMPLE PRESSURE CONTROL JOBS*

FISHER GOVERNOR COMPANY • Marshalltown, Iowa

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

Vast power projects throughout the world—more than seventy in all—attest to The Kuljian Corporation's reputation as SPECIALISTS IN THE POWER FIELD. These power plants, with capacities ranging from 2,500 to 240,000 KW, represent a total investment of over half a billion dollars.

No matter what type of power project you are planning . . . be it steam, hydro, or diesel . . . Kuljian's wealth of practical experience, backed by a complete staff of internationally recognized engineers, can serve you quickly, economically, and efficiently to meet your specific requirements.

Next time *you* need outside help, why not contact a Kuljian engineer for preliminary consultation. He will be glad to provide the help you need, anytime . . . anywhere.

ACTUAL ON-THE-JOB REPORTS are continually received at Kuljian headquarters. From these reports, easy to read case histories are developed into articles that are published by editors of leading magazines.

If you are interested in knowing more about us . . . how we work, what we have done for others . . . your request for literature will be most welcome.

The Kuljian *Corporation*

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BRANCH OFFICES THROUGHOUT THE WORLD

MARMADUKE

Continued from page 202

little steam. But he wasn't too sore and said that any guy who played a trick like that must be very hungry. 'I maka for him plenty more tomorrow,' promised Tony good-naturedly, as he calmed down.

"We kidded him that his stuff was probably pretty awful and that he dumped it over the side himself before we could sample it. But we saw his feelings were hurt so we clammed up. Next day he made another batch of minestrone. A few hours before lunch Tony again started broadcasting that he had 'justa right' minestrone. 'It'sa gonna maka you break open she'sa so good.'

"When the first order for soup came in to Tony at noon, he whipped the cover off the double-jacketed kettle with a flourish—then let out a roar. This time the old man up in the wheelhouse could hear him. This time there wasn't even a drop of soup left in the kettle, only a few peas and strings of spaghetti.

"Tony was good-natured, but this was carrying things too far. 'If a wisa guy stola soup causa he no lika soup, then I make an maka so he plenty full,' he yelled, loud enough for everyone in earshot to hear.

"That evening Tony threatened us he'd again have minestrone next day. This was war and Tony wasn't kidding. 'Thisa time nobody steal, I watcha thisa time,' he warned. 'I show wisa guy nobody maka monkey outa Tony.' By now, almost everyone was suspicious of everyone else. Some of the boys were sore. There were many arguments and a few fist fights. The bosun threatened to beat up the guy who did it—if he ever got his hands on the 'sneaky rat.'

"Next morning, Tony anchored himself in the galley, keeping a weather eye on the soup kettle. Finally, noon came and a mess boy asked for the first plate of minestrone. Tony eagerly removed the kettle's cover. Then his eyes widened and he let out a shriek. The impossible had happened. The kettle was empty for the third time.

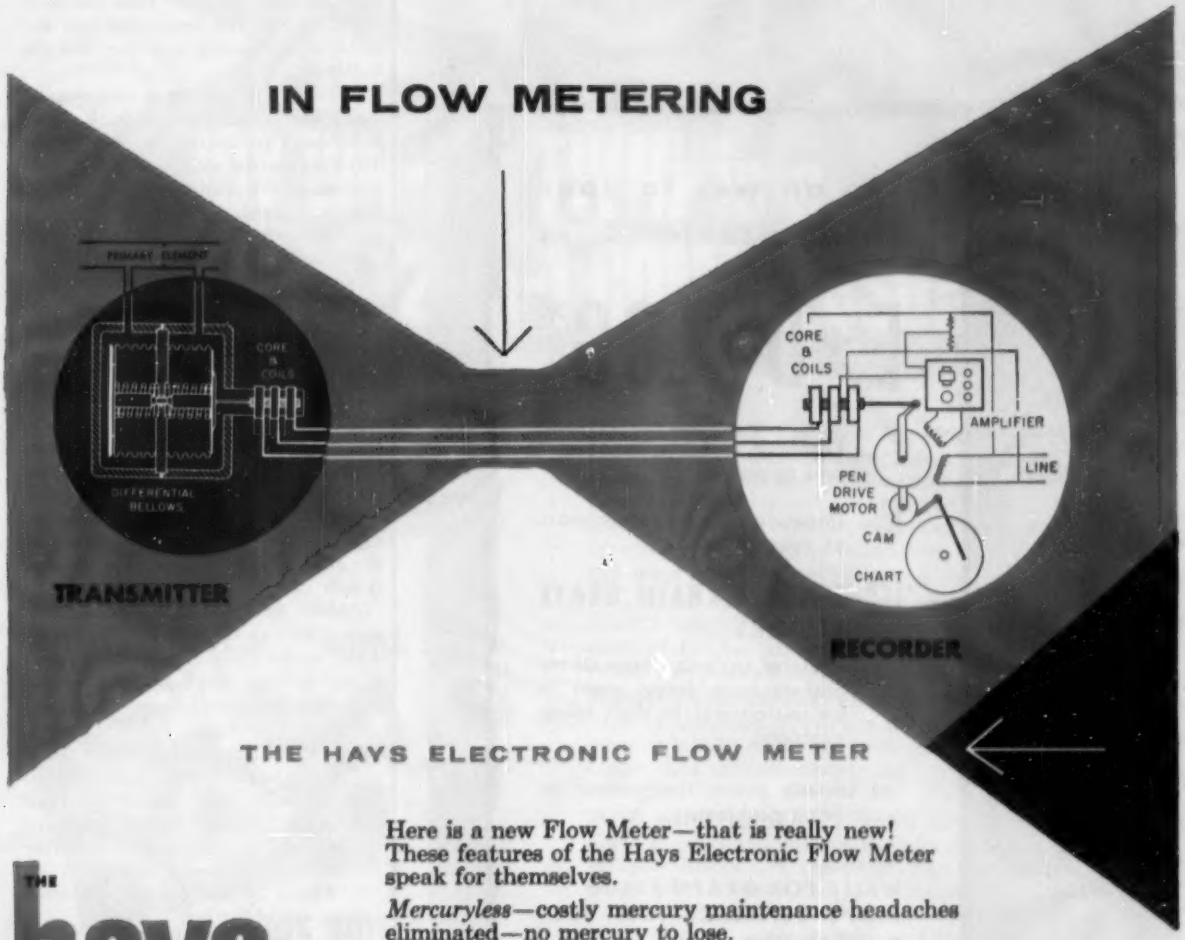
"This was too much. Tony grabbed the meat cleaver and rushed into the sailor's mess room, shouting and waving the weapon at his shipmates. 'I chopa up da guy who steala my minestrone—I no fool thisa time,' screamed Tony, his face glowing red like a port running light.

"When I heard the commotion, I barged into the galley to see what Tony was raving about. To me, it didn't seem like anyone was mean enough to foul up a good ship's cook like Tony three times in a row, and I was right.

"I found that the steam line to the kettle was fouled up and was connected to the drain connection. Tracing that

new dimensions

IN FLOW METERING



THE HAYS ELECTRONIC FLOW METER

THE **hays** CORPORATION

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Automatic Combustion Control • Varitlow Meters and Varitrol • Electronic Oxygen Recorders • CO_2 Recorders Boiler Panels • Gas Analyzers • Combustion Test Sets Draft Gages • Electronic Flowmeters • Miniature Remote Indicators • Electronic Feed Water Controls

Here is a new Flow Meter—that is really new! These features of the Hays Electronic Flow Meter speak for themselves.

Mercuryless—costly mercury maintenance headaches eliminated—no mercury to lose.

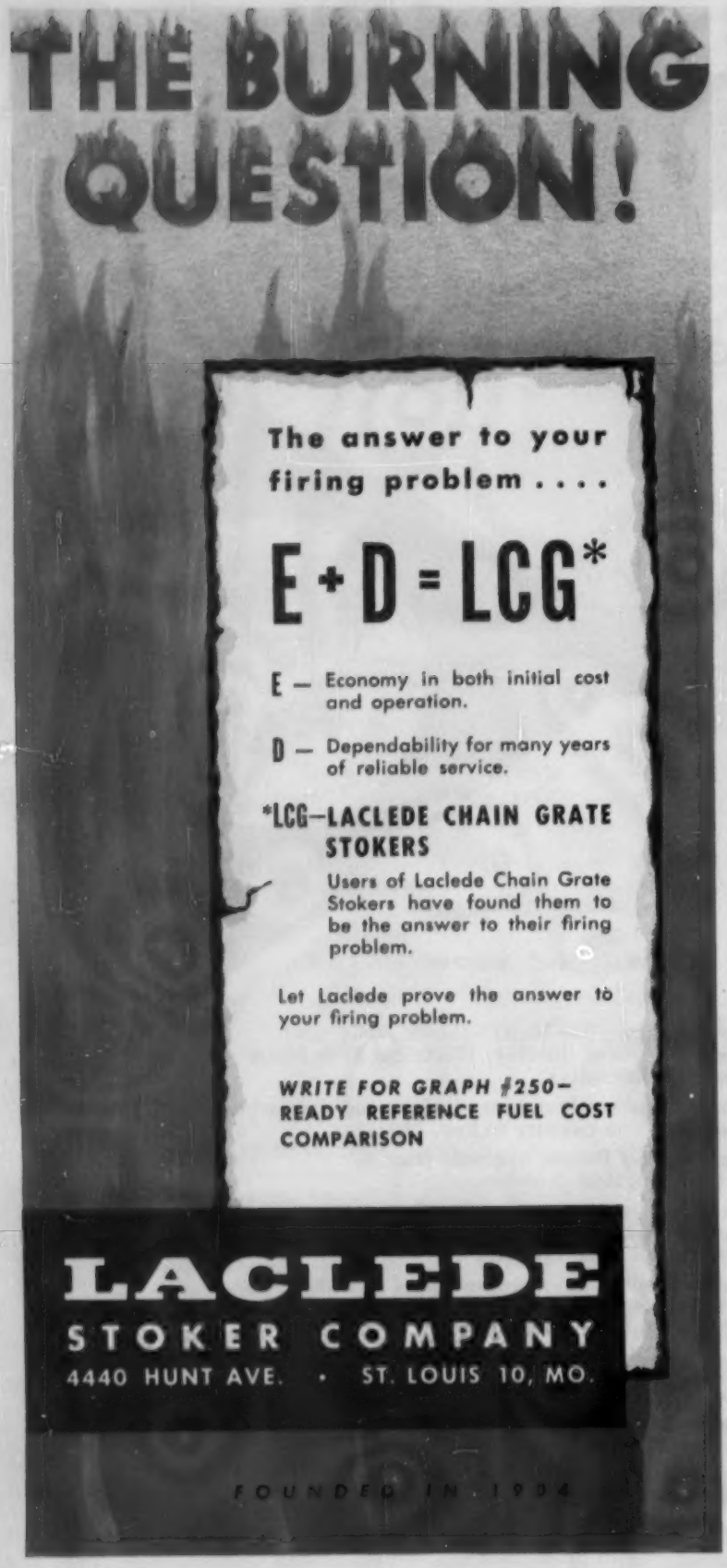
Rupture-proof Bellows—provide positive protection against over-range.

Continuous integration—motor-driven continuous mechanical integrator is extremely accurate even on rapid load changes.

Electronic operation—requires only 4 seconds for full scale pen travel with accuracy of ¼% of full scale differential.

Other features include null-balance transmission, powerful motor, easy readability, accuracy unaffected by normal temperature changes. Explosion proof transmitters and wide range meters also available.

For complete information, write for Bulletin 54-1074-222.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The answer to your firing problem . . . .
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FOUNDED IN 1904

MARMADUKE

Continued from page 204

drain led me down to the engine room. Down there, it was hooked into the atmospheric tank on the engine-room floor plates. Various steam traps drained into this tank. A float-operated valve let the overflow be sucked into the main condenser, through the vacuum drag line. From there, the condensate pump put it into the open hotwell. Then the feed pump shoved this condensate into the coil-type-feedheaters, and then into the boilers.

"I could see that was a poor system, but I hadn't had time to think about it before. That hot condensate at about 180 F was mixed with the low 90 F condensate in the condenser. So about 90 Btu for every pound of drain water was shoved overboard with the circulating water and wasted. But that hookup was standard in those days.

"I knew the efficiency of this system had nothing to do with Tony's missing soup, but wasting about two barrels of fuel needlessly each day we spent at sea griped me. I forgot all about soup and started laying out a new system in my mind. I could pump all the clean drains directly into the feedwater heater and save all that heat we were dumping over the side. But I'd have to do it after I got a lot more important bugs out of the engine room—maybe after another trip or two.

"About the time I doped out my new piping hookup in my head, the 12-to-4 water tender came over to the hotwell. 'First,' he said, 'that boilerroom Second Assistant Engineer is one smart guy.'

"'How you figure that?' I asked, hardly hearing him.

"'Well,' he answered, 'The water level in those boiler gage glasses has been a little hard to see. But the starboard boiler gives me no trouble since the Second fixed up the glasses.

"'What'd he do,' I asked, suddenly coming out of the fog.

"'Do!' he echoed, looking at me in disgust. 'He put a pea in the gage glass, that's what he did. Now that green pea floats on top and that level is easy to keep track of.'

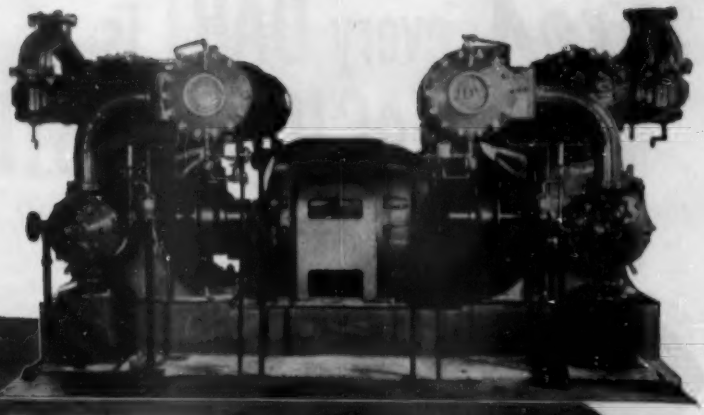
"Before I could answer he scratched his head, screwed up his face and added, 'But what I can't dope out, First, is why in hell he put a string of spaghetti in her inboard glass instead of a pea.' "—*SME*

Marmy's Mailbox

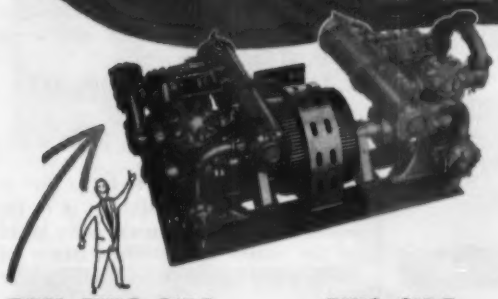
Marmy stories are the first things read in our plant. They are always looked for and promote many intensive discussions and bull sessions, from which we all get valuable dope.

L C Van Huben *Orangeburg, N.Y.*

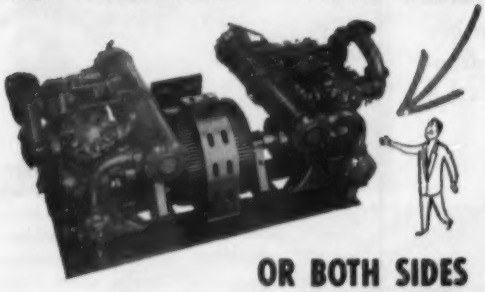
(*Continued on page* 208)



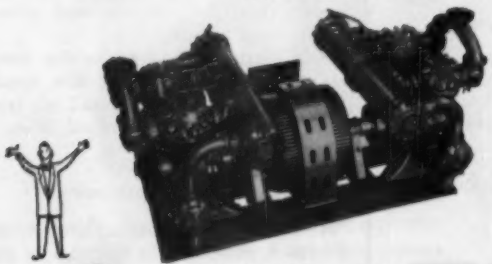
The JOY WN-114 TWIN is a 2-in-1 COMPRESSOR



RUN THIS SIDE... ...THIS SIDE



OR BOTH SIDES



SAVES FLOOR SPACE The Joy WN-114 Twin is actually two heavy duty, semi-radial compressors operating from a single motor. Because of the compact design and one power source, they make the most of limited floor space. The package-type units are delivered ready for mounting on a simple rectangular foundation.

USE ONLY WHAT YOU NEED Either compressor may be run alone by simply disconnecting its twin at the flexible coupling. As demand rises, the twin can be reconnected quickly, easily. This exceptional flexibility is ideal for plants where airpower demands vary greatly.

STANDBY INSURANCE The twin arrangement guarantees an "ace in the hole." When a conventional single compressor breaks down, its production stops completely. Under like circumstances, the Joy Twin continues at 50% capacity.

SAVES MAINTENANCE, OPERATING COSTS The WN-114 Twin is equipped with field-replaceable crosshead and cylinder liners and one-piece, box-type, tinned crossheads that require no adjustment. Patented "Dual Cushion" valves feature large area and low lift to give long, efficient, quiet operation. Displacement range is from 2372 to 3896.

For complete details on Joy WN-114 Twin Compressors, see your Joy representative, or write ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

Consult a Joy Engineer

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VACUUM PUMPS AND BOOSTERS
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(to give YOU a drop-tight seal)

This True Ball Joint Makes the Difference

Make it right . . . Test it after you make it . . . That is our rigidly adhered to policy at Dart. When you buy unions it's a good thing to remember because (1) You'll get a drop-tight union; (2) a union that can be used over and over again; (3) a union that's easy to install; (4) savings thru longer service.

QUICK FACTS

- Leakproof because precision-machined to a true ball joint and spherically ground
- Extra wide seats of bronze alloy resist pitting and corrosion
- Heavy shoulders that can take severe wrenching without damage
- Nut and body practically indestructible (of air refined, high test malleable iron)
- Individual vacuum testing of each Dart to assure absolute tightness when it leaves the factory

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CALL YOUR LOCAL DISTRIBUTOR FOR PROMPT DELIVERY OF DART UNIONS

MARMADUKE

Continued from page 206

Marmy's Mailbox

FROM AN OLD SEA DOG

I read Marmy's stories and enjoy them for various reasons. First, I was a machinist mate first-class in the Navy, so because Marmy and I are both old sea dogs, we hit it off pretty well. Second, Marmy is a shrewd old duck, and quite a cut-up at times. To me he is always funny, and he gives me many a chuckle.

DON P SCHOTT *Saginaw, Mich.*

PUT ON A SHOW

I THINK the story "Marmy murders science" (p 154, June POWER) is one of the best. I particularly like the moral of the article, which brings out the point that to make money you have to put on a show, not an exhibition.

I've heard it said that zoos exhibit animals and lose money; circuses put on a show with animals and make money. And I like circuses!

BOB WAPLES *New York, N. Y.*

AS REAL AS SHERLOCK HOLMES

Marmaduke is getting to be as real in industry as Sherlock Holmes is to the world at large. Readers who never heard of the author speak affectionately of Marmaduke Surfaceblow, as though he were a real person. Around our plant, arguments often end on a friendly note with the suggestion that we submit it to Surfaceblow.

H HOLCOMBE *Los Alamos, N. M.*

STIMULATES PRACTICAL THINKING

The new POWER is a great combination of ideas, information, etc. It's of great practical value to men who put such ideas into use. Also, Mr Surfaceblow is still providing excellent entertainment and provoking laughs, while stimulating practical thinking and giving some sound warnings.

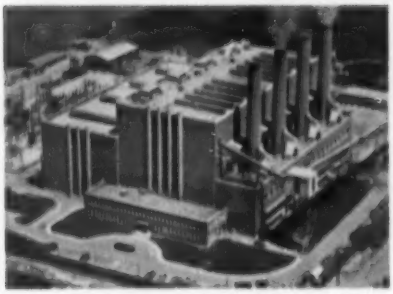
Old Marmaduke saves the day when everything goes sour; let him speak his piece as long as paper and ink last.

W B KENNEDY *McCool, Miss.*

IS MARMY'S BRAIN BOGGED DOWN?

"Marmy puts her on manual" in October POWER is excellent. In this neck of the woods we know of no good operating or consulting engineer who dissipates with barroom concoctions. So we wonder what the old boy could really do if his brain weren't bogged down with alcoholic sludge.

A W GOULD *Lowell, Mass.*



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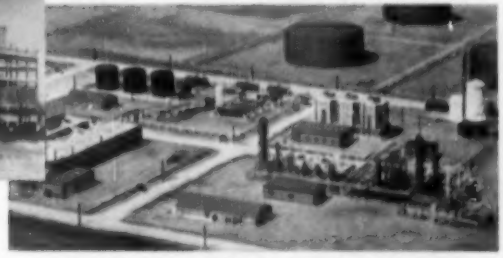

Dominion Tar and Chemical Company, Limited

Write or call us for information as to how our experience may be of assistance to you.

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New York Boston Chicago Pittsburgh Houston San Francisco Seattle Toronto

Net game or Net gain...

there's enough difference to make ALL the difference

In tournament tennis, a player's net game is one of the differences that make a champion. Likewise, significant differences in quality and performance engineered into Scovill Heat Exchanger Tube add up to a *net gain* for you in better operating results and less frequent maintenance shutdown of key units.

Scovill Phosphorized Admiralty Heat Exchanger Tube is "born" differently. It is initially hot-extruded from billets *continuous-cast* by Scovill's pioneer process. The result is sound metal through and through — smooth, dense, free from pits or porosity — and a new uniformity of chemical composition, with optimum, evenly distributed phosphorus content.

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149CSS

NEW STANODIESEL OIL M

A new stationary industrial engine lubricant developed specifically to meet problems posed by new engine designs, higher loads, economy fuels

New STANODIESEL Oil M meets—and with plenty to spare—the performance requirements imposed on diesel lubricants by new engine designs, higher loads and the use of economy fuels. It meets these requirements because, first of all, it is an oil refined from the finest quality base stocks. It thus has superior stability. Then additives exclusive with STANODIESEL Oil M have been blended with these base stocks. The additives do these things:

1	**INHIBIT OXIDATION.** Prevent unwanted increases in oil viscosity. Prevent corrosion of bearings.
2	**PROVIDE DETERGENT-DISPERSANT ACTION.** Keep crankcase, pistons, cylinder walls and other parts clean. Keep contaminants in suspension, prevent redeposit.
3	**PROVIDE ANTI-FOAM ACTION.** Foaming tendencies of oil are controlled. Oil is suitable for use in hydraulic governors.
4	**INCREASE LUBRICITY.** Wetting agent increases oil's ability to reach and maintain a film on highly stressed parts.

STANODIESEL Oil M is a "Mil" type oil.

Your next move? Find out how STANODIESEL Oil M can serve you. In the Midwest call your nearby Standard Oil lubrication specialist. Or contact Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

STANODIESEL OIL M
Does these things for your engine

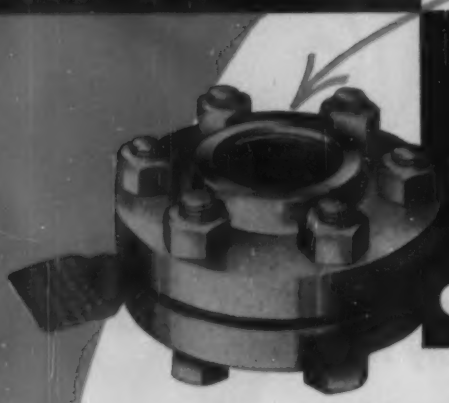
1. Lessens engine deposits, ring and cylinder wear.
2. Lessens spark plug fouling.
3. Lessens fuel injector and pump sticking resulting from engine deposits.

STANDARD

STANDARD OIL COMPANY (Indiana)

QUESTION:

When does weakness mean safety?



ANSWER:

Only When It's In BS&B *Safety Heads*

Safe, Sure Protection Against Overpressure within Pressure Vessels

Sudden Pressure, Safe Relief—that's what BS&B Safety Heads are designed to give. There's no damage to equipment, no danger to employees. BS&B Safety Heads fail within plus or minus 5% of the pressure specifications *you* give us, whether 5 lbs., 40,000 lbs., or anywhere in between.

Tested to Destruction, BS&B Safety Heads are preproved at the factory. Rupture Discs, selected at random from each lot, are put under pressure until they fail. If each one tested does not break within 5% of the rated pressure, the entire lot is discarded!

A Full, Pipe-Sized Opening results when a BS&B Safety Head Rupture Disc blows out. You can use them for primary or secondary relief where maximum protection is needed, or to back up a relief valve when the contents might prevent the valve from functioning properly. Whether *your* pressure applications are for air, gas or liquids—bland or corrosive—you can count on BS&B Safety Heads for safe, certain relief.

Write for Complete Catalog

Whatever your pressure applications, there's a BS&B Safety Head for you. Write today for the Safety Head Catalog, or ask your BS&B Man. There's no cost or obligation for a complete analysis of your pressure safety requirements.

SAFETY BS&B HEADS OUR 60TH YEAR

BLACK, SIVALLS & BRYSON, INC.

Safety Head Division, Dept. 2-Q6

7500 East 12th Street Kansas City 26, Missouri

More PLANT PROBLEMS

Begins on page 140

Steam-pressure control

Continued from page 141

Power-cylinder valve gives close control

A GOOD ARRANGEMENT that controls pressure within one psig, with load changes as high as 50,000 lb per hr, is a power-cylinder-operated valve and regulator. The regulator consists of measuring, amplifying, power and stabilizing elements, all mounted on a stand.

Power cylinder can be equipped with a power-piston air lock that holds the control valve in position, if air fails, until unlocked and controlled manually.

P DAVIDSON *Ticonderoga, N. Y.*

Positioner will improve steam-pressure control

TO HELP maintain constant steam pressure for his new chemical process, *AW* should install a valve positioner. A control-valve positioning relay would also overcome residual friction between valve stem and packing, and between valve plunger and ports.

In operation, the positioner continuously compares actual position of the valve with that called for by output pressure. It then supplies more or less air to the valve diaphragm—as needed to raise or lower the plunger.

Main advantage of the positioner is its ability to exert full air-supply pressure on the diaphragm, rather than the reduced pressure supplied from the controller.

A J BREUGELMANS *New York, N.Y.*

Intermediate-pressure control boosts accuracy

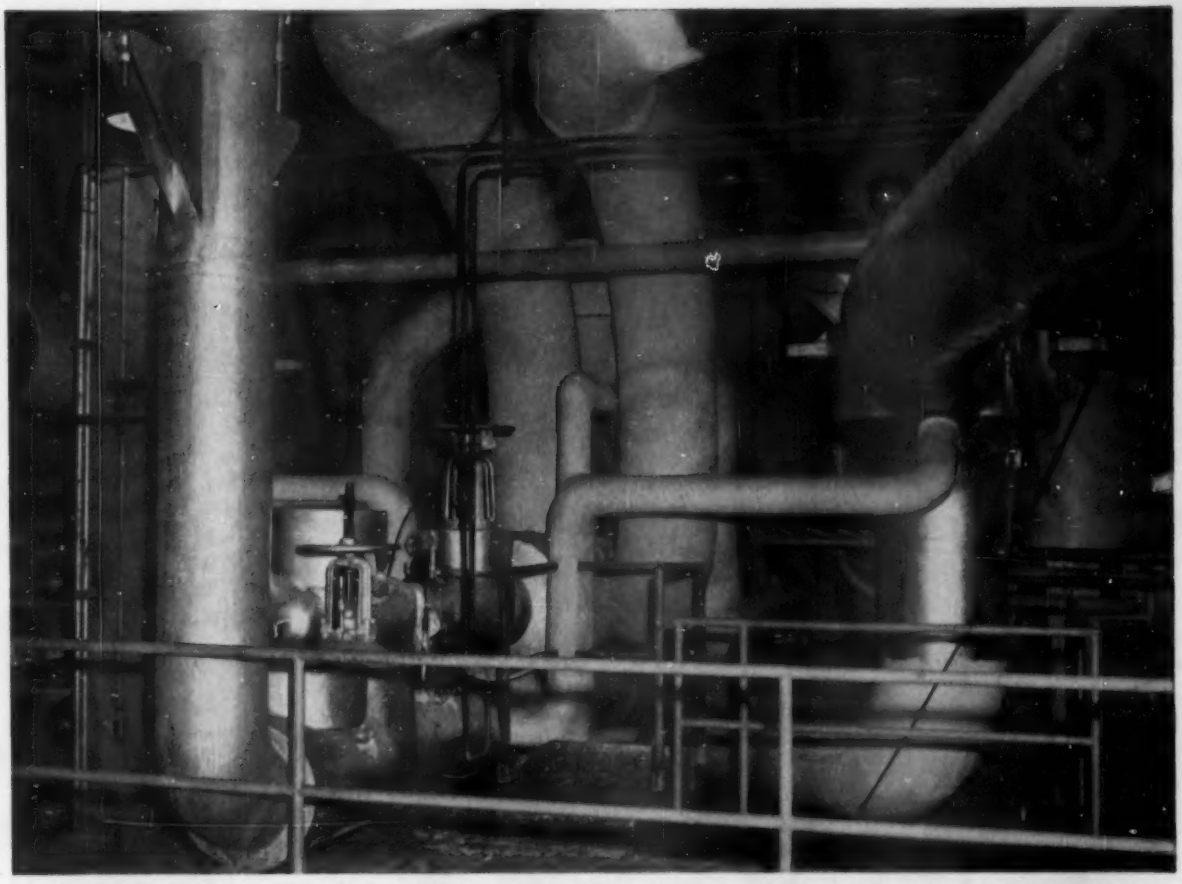
IT'S PRACTICALLY IMPOSSIBLE to maintain 300 psig with no deviation. Today's controllers can give 1 to 3% accuracy on such applications.

One way of getting better control is to install an intermediate 400-psig controller ahead of the 300-psig unit. With the 100% load swings that *AW* is getting, he should make sure the control valve is sized to handle steam flow, not to match pipe size.

L W FITZPATRICK *Jefferson City, Mo.*

Other readers sending good answers on steam-pressure controls, for which we lacked space, are:

C G HOWARTER	*Canton, Ill.*
O LE BRAGE	*Oroville, Wash.*
F LICENI	*Buenos Aires, Arg.*



A COMBINATION INSULATION. A 2 inch thickness of K&M Hy-Temp, together with a 2 inch thickness of K&M "Featherweight" insulates the pipe and main throttle valve shown. This equipment at the Meramec Power Plant, Union Electric Company of Missouri, St. Louis, operates at 950°F. Insulation Contractor: Armstrong Cork Company.

More steam at less cost with K&M high pressure insulations

Heat losses are kept to a minimum when K&M Insulations are used. Steam holds its temperature . . . users get the dollar savings that come from highly efficient conservation of heat.

K&M "Featherweight"® 85% Magnesia and K&M Hy-Temp Insulation last the life of the equipment they serve. They withstand moisture, vibration, and frequent temperature changes. Both are supplied in various sizes and thicknesses. When used together, these materials—with staggered joints—eliminate the heat loss that normally occurs in single-layer installations when expansion causes joints to open. These insulations are widely used —in power stations, hospitals, steamships, food processing plants—wherever and whenever exacting steam temperature control is a must.

Efficiency to 1900°F. K&M Hy-Temp Insulation is used on applications where temperatures rise to 1900°F. It's made of diatomaceous silica combined with heat-resistant mineral fillers and asbestos fiber. Usually, it's applied in combination with K&M "Featherweight" 85% Magnesia.

Efficiency to 600°F. K&M "Featherweight" 85% Magnesia is used for effective insulation of piping and equipment with temperatures up to 600°F. 85% of this material is composed of basic carbonate of magnesia, the remainder of asbestos fiber.

Efficiency to 450°F. K&M "Featherweight" Water-Resistant Magnesia Insulation is used on equipment with temperatures up to 450°F. It is especially effective where severe water exposure may damage insulation, or where high humidity and moisture are present.

Don't delay—act today! When you save on heat losses, you save on operating expenses. For further information—and the name of your K&M distributor, who is an experienced applicator, write to Keasbey & Mattison Company.

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K&M best in asbestos®

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wide open . . .
or shut tight —
in a FLASH!

It takes less than a quarter turn to open an Everlasting Valve *wide* or close it *tight*. That's one of the many reasons why these time-proven valves are so popular wherever quick valve action is desired . . . on equipment outlets, storage and measuring tanks, process lines, boiler blow-offs, spray lines, meter testing, etc.

Write for Bulletin E160 describing their many other important advantages and with full information on types, sizes, etc.

For "everlasting" service, use

EVERLASTING Valves

EVERLASTING VALVE CO.
45 FISK STREET, JERSEY CITY 5, N. J.

EV309

NUCLEAR PLANT

Continued from page 112

depends on processing of spent elements.

4. Waste disposal includes cost of preparing radioactive waste material for storage and burial.

5. Operating and maintenance personnel include men for: reactor plant, coolant systems, steam-electric plant, health - physics section, maintenance shops, security guards.

6. Expendable supplies for personnel noted above.

Potential income from a nuclear power plant includes sale of: (1) electric power (2) fissionable material. Actual revenue depends on type of reactor plant. Table 3 shows two ways of estimating plant revenue.

There is the possibility that various grades of fissionable material will bring different prices. For example, a so-called "weapons grade" plutonium could possibly bring a much higher price than a low-grade high-impurity fissionable material.

Method *A* is more conservative than *B*, but we feel that eventually this will be the only realistic approach to determining economic feasibility of nuclear power plants.

Considering a nuclear plant with a breeder reactor we can estimate the fissionable material produced as follows:

$Kg = Mw \times G \times BR \times LF \times OD$

where

Kg = total kilograms of fissionable material produced per year

Mw = reactor rating in mw

G = total grams of fissionable matter consumed per mw-day; depends on fuel material, reactor type and power rating

BR = breeding ratio; depends on reactor type, reactor fuel, diluent, fertile material; expressed as total grams of fissionable material produced per gram of fissionable fuel consumed (burned up)

LF = load factor expressed as a ratio of reactor load to reactor rating

OD = number of operating days per yr

Heat-energy equivalent for fissionable material is found as follows:

1. Based on Einstein's mass-energy equation, one lb of mass equals 11.6×10^9 kwhr of energy.

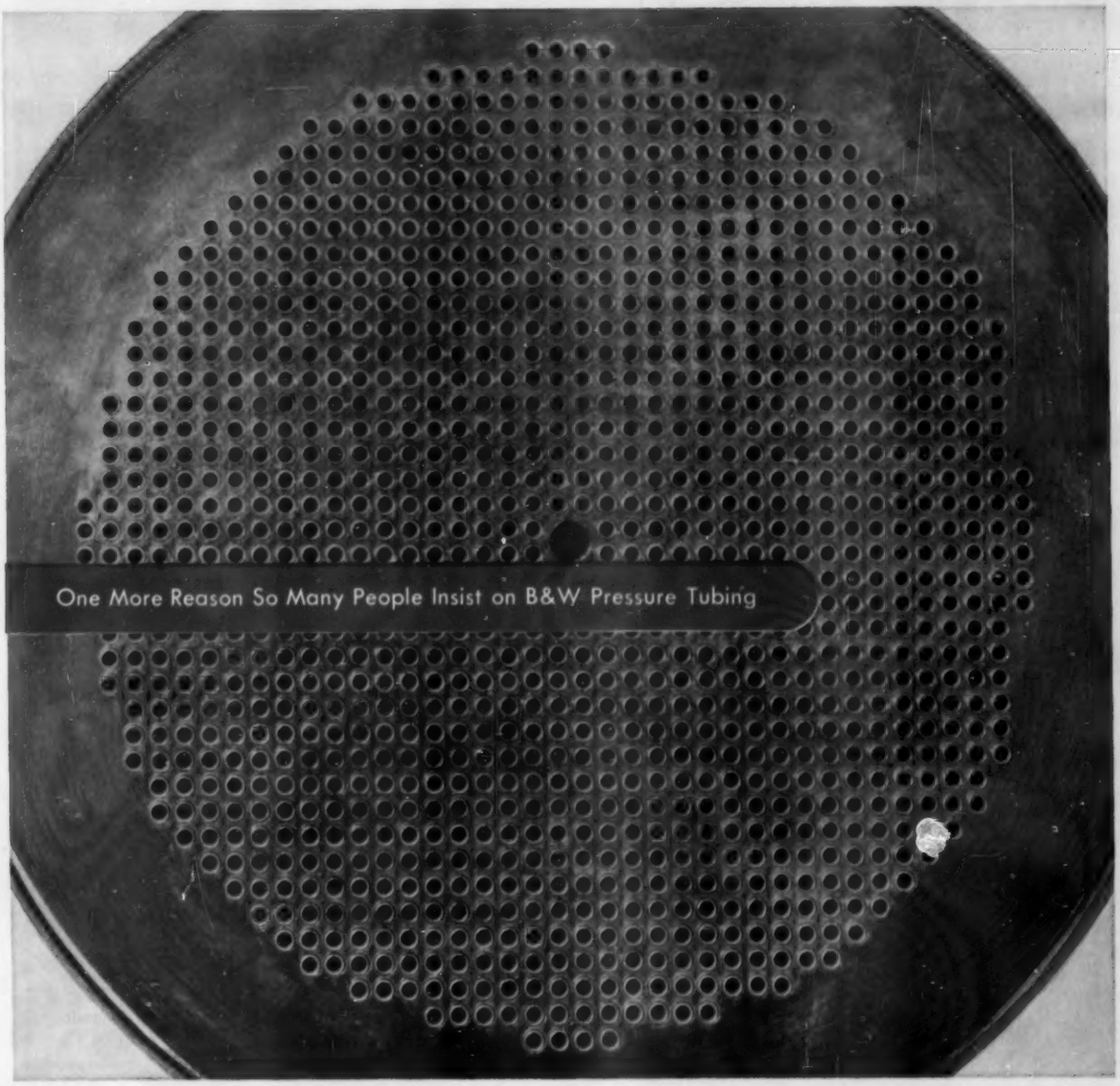
2. When all the nuclei in the atoms of one lb of fissionable material, U-235, fission, about 0.001 lb of material converts to energy.

3. Then $11.6 \times 10^9 \times 0.001 \times 3413 = 39.5 \times 10^9$ Btu per lb U-235.

Assuming one ton of coal has 24×10^6 Btu, then:

$39.5 \times 10^9 / 24 \times 10^6 = 1650$ tons coal per lb of U-235

That is, it takes 1650 tons of coal to



B&W TUBING UNIFORMITY – MULTIPLIED 1194 TIMES

If you had this many tubes to roll in, there would be no delay if you used B&W tubes.

For heat exchangers, for condensers, in fact for every pressure tubing application, you can rely on B&W tubing for uniform wall thickness, uniform ductility, tight joints, and low installation cost.

Always specify B&W pressure tubing. It meets all dimensional and mechanical requirements, and is available, in all commercial sizes, in a wide range of carbon, alloy and stainless grades. *Write for Technical Bulletin 329P.*

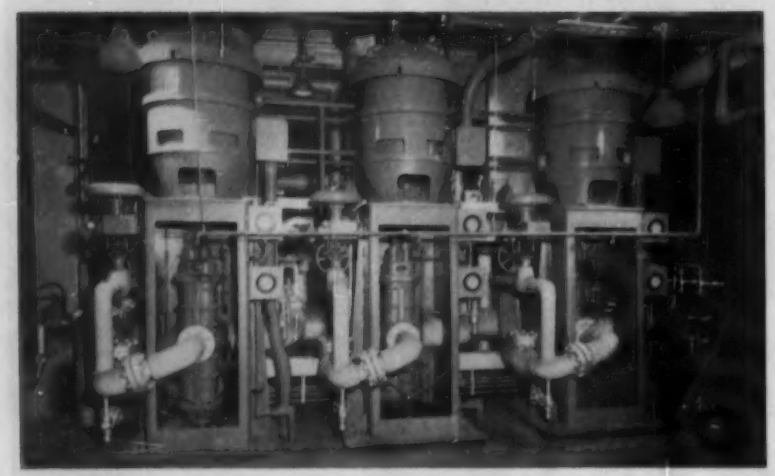
B&W TUBULAR PRODUCTS DIVISION

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa. and Milwaukee, Wis.: Seamless Tubing. Welded Stainless Steel tubing
Alliance, Ohio: Welded Carbon Steel Tubing
Milwaukee, Wis.: Seamless Welding Fittings

TA-5019(P)

WARREN-QUIMBY SCREW PUMPS USED in the PROCESS of GENERATING STEAM for the WORLD'S TWO HIGHEST TEMPERATURE STEAM TURBINES at

Public Service Electric and Gas Company



ENGINEERING progress marches on and the installation of two of the world's first 1100°F. steam turbines at the new Kearny Station of Public Service Electric and Gas Company in New Jersey, marks another important advancement. Two 145,000 kw. reheat units have initial temperature of 1100°F., pressure of 2350 psig, and reheat temperature of 1050°F. Utilizing these advanced steam conditions results in definitely lower generating costs.

Three Warren-Quimby Gear-in-Head, Vertical Screw Pumps were selected for fuel oil service in connection with this important installation. These pumps are of cast steel with center bearing, and handle Bunker "C" fuel oil at an operating temperature of 125 to 135°F.; viscosity 1500 to 2500 S. S. U.; capacity, 180 g.p.m.; 1150 r.p.m.; suction pressure, 20" Hg. lift; discharge pressure 775 psig.

Keep in step with progress . . . specify: WARREN QUIMBY PUMPS

WARREN PUMPS

WARREN STEAM PUMP COMPANY, INC.

Warren, Massachusetts

NUCLEAR PLANT

Continued from page 214

equal the heat produced by one lb of U-235.

To measure heat energy in dollars, let's assume heat is worth 40c per million Btu, then $39.5 \times 10^9 \times 0.4/10^6 =$ \$15,800 per lb U-235 = about \$34.80 per gram of U-235.

Electric energy produced and available for sale depends on: reactor rating, station auxiliary-power need, net station thermal efficiency, plant load factor. Annual output can be estimated as:

Kwhr = net kw rating × 8760 × % load factor/100

Net kw rating = reactor power, kw × net station thermal efficiency, %/100

Next in the series will cover heat transfer in reactors and coolant systems, in a forthcoming issue.

More ARGUMENTS

Begins on page 146

The inspector who had previously approved it would take a dim view of the proceeding.

Brickwork erosion at the fire line is quite common. It should not be necessary to renew the entire lining if it is in good condition otherwise, provided the eroded section can be removed without collapsing the entire wall.

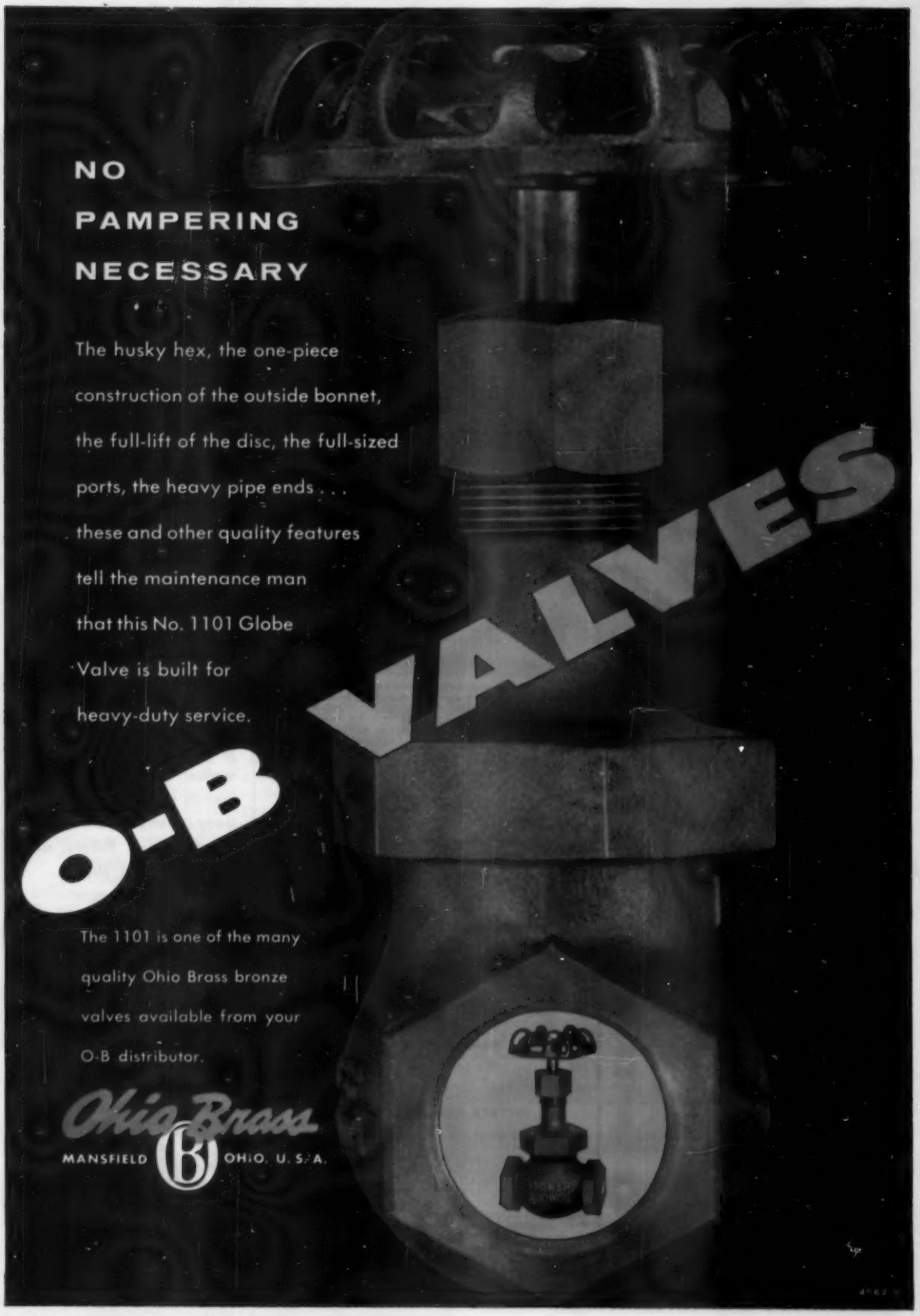
A 250-hp boiler is probably lined with "first-quality" firebrick. I would suggest using "super-duty" firebrick for four or five courses around the fire line. An even simpler repair is to cut out the eroded section, preferably in a dovetail form to insure a strong bond. Fill with a good plastic refractory pounded in with a steel or wooden mallet. The refractory fills every void. Such patches often outlast the original firebrick.

W J STEINERT

Fresh Meadows, N. Y.

Two 3400-kw, 4160-v duel-fuel generators, built by Electric Machinery Mfg Co, have been put into operation at the Great Bend, Kansas plant of Central Kansas Electric Corp, Inc. This boosts plant generating capacity to 10,520 kw, all installed since 1947. Engines, used to drive these generators, are 9 cylinder, 21½ x 27½-in., 257 rpm, 2-cycle units. They were built by Baldwin-Lima-Hamilton Corp.

New motion picture, in full color with sound, is entitled "Nothing but the best" and is available on loan from Air Reduction Sales Co, 60 E 42nd St, New York 17, N. Y. The film tells the story of the company's tungsten inert-gas arcwelding process. Running time is 20 minutes.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NECESSARY
The husky hex, the one-piece construction of the outside bonnet, the full-lift of the disc, the full-sized ports, the heavy pipe ends . . . these and other quality features tell the maintenance man that this No. 1101 Globe Valve is built for heavy-duty service.
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The 1101 is one of the many quality Ohio Brass bronze valves available from your O-B distributor.
Ohio Brass
MANSFIELD OHIO, U. S. A.

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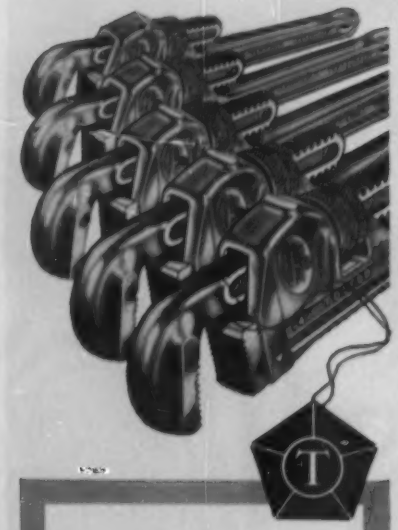

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MAKERS OF THE WORLD'S FINEST PIPE TOOLS

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More FREE BULLETINS

Begins on page 173

16 **Transformers.** An 8-page reprint, "Performance characteristics of 150 C rise dry-type transformers," discusses new insulation methods and materials. Bulletin 61R8246. Allis-Chalmers Mfg Co, Milwaukee 1, Wisconsin.

SAFETY AND MAINTENANCE

17 **Protective helmets** for industrial workers, miners and fire-fighters. Photos and descriptions in 16-page bulletin 0600-3. Mine Safety Appliances Co, 201 N Braddock Ave, Pittsburgh 8, Pa.

18 **Grating, stair treads,** open steel floor armor, vessel liners, bridge decking and drain grates are described in 16-page data and specification manual. Kiemp Metal Grating Corp, 6605 S Melvina Ave, Chicago 38, Illinois.

19 **Floor care.** Illustrated 8-page bulletin contains data on scrubbing machines, industrial vacuum cleaners, rug and upholstery cleaning equipment, furnace cleaning units, sanding machines, waxes, sealers and preservers. Multi-Clean Products Inc, 2277 Ford Pkwy, St Paul 1, Minn.

20 **Geared head wrench** is designed for jobs requiring rotary force settings over 200-ft lbs. Photos, applications, specs in 4-page bulletin. Bonney Forge & Tool Works, Allentown, Pa.

21 **Lubrication wall chart** gives recommendations for maintenance of hydraulic systems, spindles, air compressors, reduction gears, electric motors and other general uses. E F Houghton & Co, 303 W Lehigh Ave, Philadelphia 33, Pa.

22 **Lubricants** for fringe area lubrication at extreme bearing pressures, high, low and normal temperatures. Various types described in bulletins 102 and 103. The Alpha Corp, 65 Harvard Ave, Stamford, Conn.

MATERIALS HANDLING

23 **Modern material handling** is subject of 32-page illustrated booklet. Covers unit-load principle, power requirements of industrial trucks, and characteristics of nickel-iron alkaline storage batteries. Edison Storage Battery div, Thomas A Edison Inc, West Orange, N. J.

24 **Industrial trucks** and trailers are illustrated and described in 17-page bulletin 60-343. Capacities and specs. The Colson Corp, Elyria, Ohio.

25 **Hydro-ejector** for hydraulic materials handling systems. This jet pump is designed to pump a mixture of solids and water through a transporting pipeline. Illustrated 4-page data sheet Ea. The Allen-Sherman-Hoff Co, 259 E Lancaster Ave, Wynnewood, Pennsylvania.

MECHANICAL TRANSMISSION

26 **Flexible couplings.** Illustrated 8-page pocket-size selection guide contains technical data, specs, application info on rubber-bronze bushed flexible couplings. Bulletin 57. Ajax Flexible Coupling Co Inc, Westfield, N. Y.

27 **Drive unit** using *Poly-V* belt is subject of 36-page bulletin PV-200-A. Contains specs, engr data, selection charts and photos. Browning Manufacturing Co, Maysville, Kentucky.

METALS AND ALLOYS

28 **Steel forgings.** Illustrated 4-page bulletin describes operation of steel forging business integrated from electric steel making to finished machining. National Forge & Ordnance Co, Dept 100, Irvine, Warren Co, Pa.

29 **Technical reprint,** "A selection guide to corrosion-resistant cast alloy" defines various corrosion-resistant cast alloy grades and their general uses. Illustrated 16-page bulletin. Alloy Casting Institute, Mineola, N. Y.

30 **Cupro-nickel alloys.** Illustrated 12-page reprint provides tabu-

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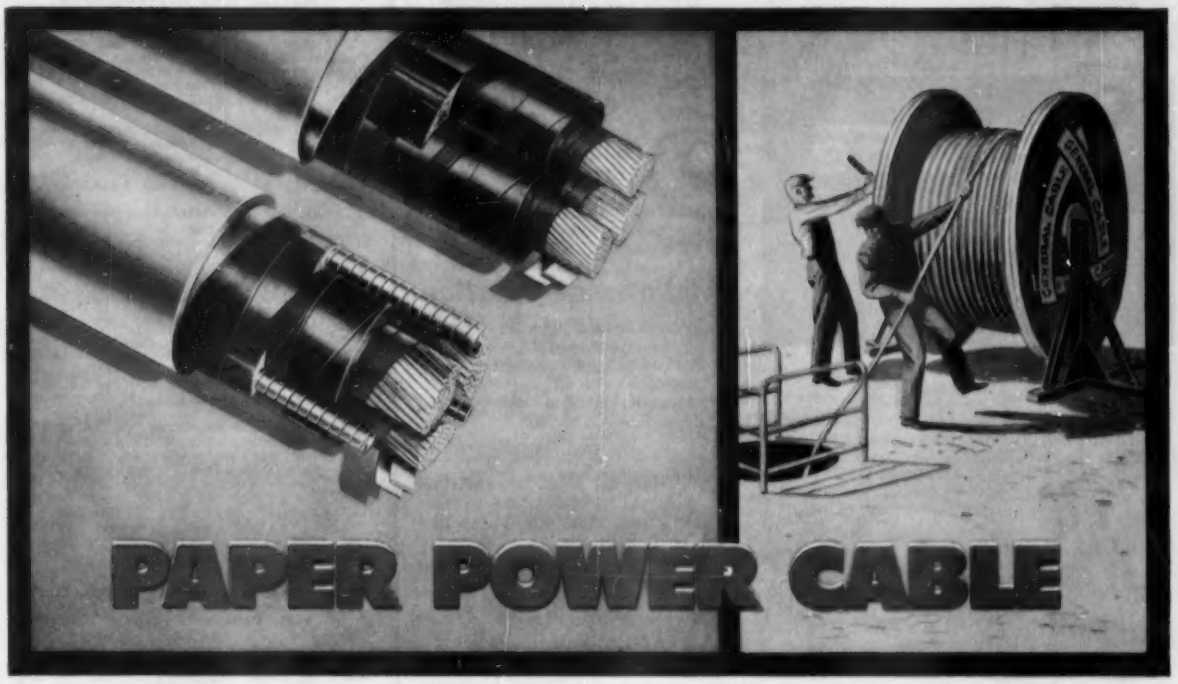

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Available in widest range of conductors: Compack Round, Concentric, Compack Sector, Annular Concentric, Compack Segmental, Hollow Core.

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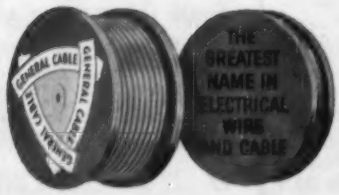

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Layne & Bowler engineers have designed the Verti-Line Turbine Pump to strike a balance between first cost and operating cost—to give the owner most for his pumping dollar for years and years.

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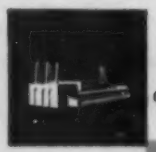

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More FREE BULLETINS

Begins on page 173

lated data on performance in specific service in various industrial fluids. The International Nickel Co, Inc, 67 Wall St, New York 5, New York.

METERS AND INSTRUMENTS

31 **Side indicator meters** have initial accuracy of ±2% of full scale deflection on dc and ±5% on ac. Two-page data sheet gives description and specs. International Instruments Inc, Box 2954, New Haven 15, Connecticut.

32 **Vibrating reed tachometers** for portable use or stationary mounting. Photos and specs in 8-page bulletin 770. Herman H Sticht Co, Inc, 27 Park Pl, New York, New York.

★ **Electric tachometers** for continuous-duty operation. 20-page bulletin 540 contains data on 10 magneto types with accessories for connecting magnetos to drive source. ★Request direct on company letterhead. Electric Tachometer Corp, 2220 Vine St, Philadelphia 3, Pa.

33 **Smoke density indicator** and alarm. Specs, photos, dimensions in 2-page bulletin E-103. Reliance Instrument Manufacturing Corp, 190 Glen Cove Ave, Glen Cove, L. I., New York.

34 **Liquid level gages** for indicating, recording, controlling and telemetering are described in illustrated 26-page bulletin L701. The Bristol Company, Waterbury 20, Connecticut.

PIPING, VALVES, FITTINGS AND SPECIALTIES

35 **Insulated piping systems** for underground or overhead use. Photos, specs, drawings, applications, connections, accessories in 24-page bulletin 55-1. Ric-wiL, Inc, Barberton, Ohio.

36 **Automatic expansion valves** with nominal capacity of ¾ to 1¾ tons. Schematic views, engr data, applications, full specs in 6-page bulletin E210. A-P Controls Corp, 2450 N 32nd St, Milwaukee 45, Wisconsin.

37 **Bronze valves.** Illustrated 8-page bulletin B255 covers 55 different types of valves including gate, angle, globe, check, needle point, relief, and others. Milwaukee Valve Co, 2275 S Burrell St, Milwaukee 7, Wisconsin.

38 **Steam traps** for pressures to 600 psi and temperatures to 950 F. Specs, capacities in illustrated 4-page bulletin 255-A. Sarco Co, Inc, Dept P, Empire State Bldg, New York 1, N. Y.

39 **Welded fittings** for every piping service is subject of fully illustrated 28-page bulletin W-4. Contains data on typical installations, installation procedure, full specs. Bonney Forge & Tool Works, Allentown, Pa.

40 **Flexible metal hose.** Application data, specs, couplings, selection info in 12-page illustrated bulletin 147. Flexonics Corp, 1301 S 3rd Ave, Maywood, Illinois.

41 **Protective closures** for threaded parts, pipe and tubing ends. Available sizes, specs of rubber and plastic caps and plugs in illustrated 4-page bulletin 55-1. Ray A Scharer & Co, 3000 E Grand Blvd, Detroit 2, Mich.

PRIME MOVERS AND ACCESSORIES

42 **Hydraulic turbines.** Illustrated 22-page bulletin 1001 describes types of units and associated equipment that have been built for hydro projects. Contains approximate equations used as a guide in preliminary selection of turbine speeds and sizes. Baldwin-Lima-Hamilton Corp, Philadelphia 42, Pa.

43 **Diesel engines,** sizes 375 to 1000 hp, are described in illustrated 20-page bulletin 10040. Photos, cutaways and specs. Ingersoll-Rand Co, 11 Broadway, New York 4, N. Y.

★ **Turbine generator sets** are subject of 36-page bulletin. Contains

(Advertisement)

HALL LABORATORIES, INC.—A SUBSIDIARY OF HAGAN CORPORATION, PITTSBURGH, PENNSYLVANIA

Hall Industrial Water Report

VOLUME 3 JUNE 1955 NUMBER 3

It Takes a Lot of Water Conditioning To Manufacture Textiles

Wizardry in the research laboratories has created a new world of fabrics, but the finished cloth is still a product of the operating engineers' know-how. And they have to use water to put their know-how to work. A ton of rayon, for example, requires about 830 tons of water in its manufacture, while about 160 tons of water are needed to produce one ton of finished wool cloth.

That's why Hall Laboratories, as water engineering consultant, plays such a vital role in the manufacture of textiles.

High Water, Low Water

Variable flow in the river supply helped show the need for competent water management in a southern acetate rayon plant.

During one spring flood, plant operators battled for 48 hours to keep excessive solids down in the high-pressure boilers. Turbidity, silica and suspended material in the softener effluent kept climbing in spite of increased chemical feed and boiler water silica concentration rose to high levels in spite of higher blowdown.

At the height of the flood, the utilities engineer secured water samples throughout the system for study by Hall. Dissolved silica in the flood water was found to be low, but much of the suspended material was quartz. Analysis of the other samples showed that more and more of this crystalline silica had dissolved as the temperature and pH of the water increased in the softener and boilers.

With the help of Hall field engineer W. J. Reese plant personnel improved softener operation and set up procedures which would enable them to better handle the next flood.

Six months after the flood came a drought and a new problem. Because of the high solids dissolved in the river water, boiler water concentrations quickly became high enough to cause carryover. Working with the plant personnel, Reese was able to bring operations back to normal.

Now more precise control all through the water cycle guards against future critical periods.

Water Detectives Reduce Problem to Grease Spot

Rejection of cloth, valued by the manufacturer at $75.00 a yard, represented a serious loss to a woolen mill in the Great Lakes area. Brown stains were spotting the cloth in the last step of the finishing process where the wool was rolled on a perforated drum through which hot water was circulated to "crab" or set the fibers of the material.

Because the staining was first believed to be iron carried into the hot water lines by iron-fixing bacteria originating in the well water, the plant was considering the expenditure of several thousand dollars for the installation of equipment at each of three wells to kill off the "bugs." When Hall staff engineer H. A. Reda was called in to investigate the problem, he enlisted the aid of E. T. Laurin, Hall headquarters expert on textiles and textile processing. The combined work of Reda at the plant and Laurin in his lab brought out the fact that the "iron deposits" on the cloth were not iron at all but wool grease. This was being loosened from the cloth itself by the heat of the recirculated process water and was then redeposited even though the recirculated hot water passed through filter cloth. After the condition was recognized, more frequent changing of filter cloth minimized the difficulty.

In the course of the investigation, Reda uncovered other conditions which could lead to trouble. Recommendations were made to control corrosion in the softened hot water system with Calgon® and to set up proper water conditions in the boilers.

* * *

Textile manufacturing today demands the services of many specialists. The remarkable textiles available now would be non-existent without expert control of each production step. Hall Laboratories has kept pace with each development in textile technology, so that the industry could have full control of its most important raw material . . . water.

Supercritical Conditions Pose New Problems

Will there be new problems when water is used in the supercritical range for generation of power at 5000 psi and 1200 F? In a paper presented on April 4 at the Diamond Jubilee Mechanical Engineering Conference of the American Society of Mechanical Engineers, Dr. Everett P. Partridge, Director of Hall Laboratories, Inc., points out what may happen as a result of the increased solvent power of water as pressure and temperature go up. A limited number of multilith preprints are available on request.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information, write, wire or call Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

Water is your industry's most important raw material. Use it wisely.

Hall Laboratories, Inc.—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

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Safeguard your eyes from scalding steam and flying glass. Watch your water level safely through SONDERGLASS, the safe gauge glass. Virtually two tubes in one . . . the outer hardened to resist cold drafts and erosion . . . the inner to withstand great heat.

Sonderglass has been dipped into 450°F oil and repeatedly plunged into cold water without spalling or cracking.

Today, equip your boilers with the safe glass — Sonderglass — and enjoy the satisfaction of knowing that you have the best.

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Spragrip is an entirely new development and unlike any other belt dressing you have ever used. It is a permanent type dressing that gives an immediate power boost and will not lose its grip due to aging, oxidizing, glazing or drying out on the belt. Treat your V, flat, round, leather, rubber or fabric belts the easy way. Just press the button on the modern pressurized can of Spragrip and safely spray hard-to-reach sheaves and belts with this power boosting formula. The same formula is packaged in spout applicator cans under the trade name Belt-Flo. Money back guarantee. Write the A. W. Chesterton Co., Everett 49, Mass. for full information.

More FREE BULLETINS

Begins on page 173

full descriptions and transparent sectional views. ★Request direct on company letterhead. AEG Allgemeine Elektricitats-Gesellschaft, Berlin, Germany.

WATER TREATMENT

44 **Waste treatment equipment** for industrial and municipal applications. Illustrated 4-page bulletin WC-117 covers basic types of equipment available for treatment and typical installations. Graver Water Conditioning Co, 216 W 14th St, New York 11, New York.

45 **Acidizing service** for water wells is subject of illustrated 4-page bulletin 754. Case histories, methods, advantages. Dowell Inc, Tulsa, Okla.

46 **Technical reprint** entitled "The status of demineralizing in today's plants." Includes cost and performance curves for present day systems. Graver Water Conditioning Co, 216 W 14th St, New York 11, New York.

WELDING

47 **Stud welding** standardized specifications. Sixteen-page pocket-size bulletin covers ordering and engr data of 12 most commonly used studs. Also review of uses and equipment. KSM Products Inc (Stud Welding div), Merchantville 8, N. J.

48 **Croloy electrodes.** Welding characteristics, applications, AWS and ASTM specs in detailed 19-page report. Champion Rivet Co, Harvard & E 108th St, Cleveland, Ohio.

49 **Technical reprint** "Iron power electrodes and their application," Lincoln Electric Co, Cleveland 17, Ohio.

MISCELLANEOUS

50 **Centrifugal pumps** from ¼ to 75 hp sizes for delivery of 5 to 2800 gpm. Illustrated 24-page bulletin 7093-E covers entire line of close-coupled *Motorpumps*. Cutaways, features, specs, typical applications. Ingersoll-Rand Co, 11 Broadway, New York 4, New York.

51 **Air cylinders**—200 psi units from 1½ to 14 in. bores in strokes up through 22 ft—and 17 standard mounting styles, are described in illustrated 8-page bulletin A-105K Miller Fluid Power Co, 2040 S Hawthorne Ave, Melrose Park, Ill.

52 **Heat exchanger** and condenser tubes. A typical specification, ASTM A-214, covering this grade of tubing is broken down to show how it is processed to meet each requirement in the specification. Illustrated 12-page bulletin HEC-1. Republic Steel Corp, Steel & Tubes div, 224 E 131st St, Cleveland 8, Ohio.

Belgian mining concern of Union Miniere du Haut Katanga is the first company outside of the U.S. to join the Atomic Industrial Forum, Inc. The company operates the famed Shinkelobwe uranium mine in the Belgian Congo.

New hydroelectric plant generating 52,000 kwhr has gone into operation at the Tepalcatepec basin in west central Mexico. It will provide critically needed power in important industrial centers such as Guadalajara, Mexico's second largest city.

Salt River Power District in central Arizona has purchased an 80-acre site for a new 100,000-kw steam power plant. Plans are to use 20 acres for the $13 million plant and add another 100,000-kw unit when demand arises. Work will begin in August.

why soot is no problem... with the Ljungstrom® Air Preheater

Soot is no problem with the Ljungstrom. Clinging soot or slag is loosened by normal expansion and contraction of the preheater . . . and most of it is blown away by the high-velocity gas streams. What remains is removed by superheated steam or compressed air, fired from oscillating soot blowers, while the Ljungstroms are in operation.

What's more, moderate deposits on the Ljungstrom heating surface have no effect on preheating. For, with the Ljungstrom, heat need not pass through a film-coated wall — but is simply absorbed by a heating surface and *released from the same surface.*

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Advantages of the Ljungstrom Air Preheater

- Size for size, recovers *more* heat than any other type.
- Reduces fuel consumption. Permits use of lower-grade fuels. Increases boiler output and reliability.
- Eliminates cold spots . . . keeps corrosion to a minimum.
- Easier, faster to clean and maintain.
- Requires far less supporting steel and is quickly erected.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

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FAST DELIVERY OF ALL POPULAR MODELS:

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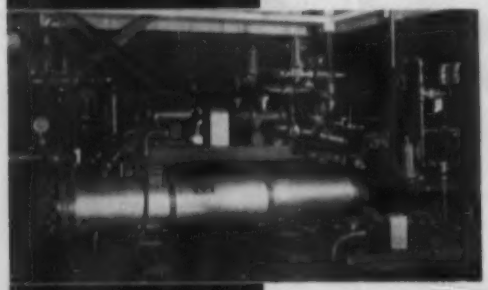
For heavy bunker oil or light furnace oil . . . 100 to 10,000 gallons per hour

Enco systems employ one, two or more pumps and heaters, interconnected so that full capacity is possible with any combination of pumps and heaters. Flexibility of design permits the use of any combination of rotary pumps, with motor or turbine drive; or piston type steam pumps. Any part may be cut out of operation for inspection or cleaning, without shutting down, where two or more pumps and heaters are included in the unit system.



Heaters are insulated and jacketed with removable heads at both ends for cleaning without breaking any piping connections or removing any tube bundles.

Full automatic oil pressure and temperature control, with relief valves for each pump and heater. Permits delivery of oil with safety, and at proper temperature and pressure for efficient burning.

Each unit is built to order and delivered ready to place on foundation and for connection to the station piping.

Write for Bulletin OB-53 describing Enco Gas and Oil Burners; and Pumping and Heating Equipment.

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EC 5108

More TECHNICAL BRIEFS

Begins on page 160

plant were examined to check calculated service creep rates, assess creep damage, and to compare long-time performance predictions based on short-time laboratory data.

Remarkable correlation was observed between calculated service creep rates and those established by subsequent laboratory creep testing. Full agreement with average values used by the Subgroup on Allowable Stresses for Ferrous Materials of the ASME Boiler Code Committee in setting allowable stresses for this material was established for both creep and stress-rupture properties. *ASME paper no. 54-A-73.*

Effect of a globe valve in approach piping on orifice meter accuracy. *By J W Murdock, C J Faltz and C Gregory, Jr, U.S. Naval Boiler and Turbine Laboratory.*

The change of indicated flow rate due to a globe valve placed six diameters before an orifice is 2%, or less, for orifice ratios less than 0.75. For greater ratios, spread of data with or without the valve in the line is of such magnitude that valve disturbance cannot be distinguished from reproducibility, and no conclusions can be drawn from the data.

Exact location of the point of no interference is difficult to ascertain. General agreement of data was obtained between the comparative and weighed tests. Neither use of steam or water, nor location of pressure differential taps at the flange or radius positions showed any significant influence on results obtained. The effect of globe-valve throttling down to 20% relative opening was negligible. Curves are presented for estimating probable error of an installation. *ASME paper no. 54-A-122.*

Pressure vessels

The design of vertical pressure vessels subjected to applied forces. *By E O Bergman, C F Braun & Company.*

Pressure-vessel codes do not give design methods except for relatively simple case of cylindrical shells with standard-type heads and openings under uniform pressure. The designer must apply engineering principles when he deals with more complicated structures and loading systems.

This paper discusses some design principles not covered in the codes. It deals with vessels subjected to various applied forces acting in combination with internal or external pressure. Vessels considered are limited to those with

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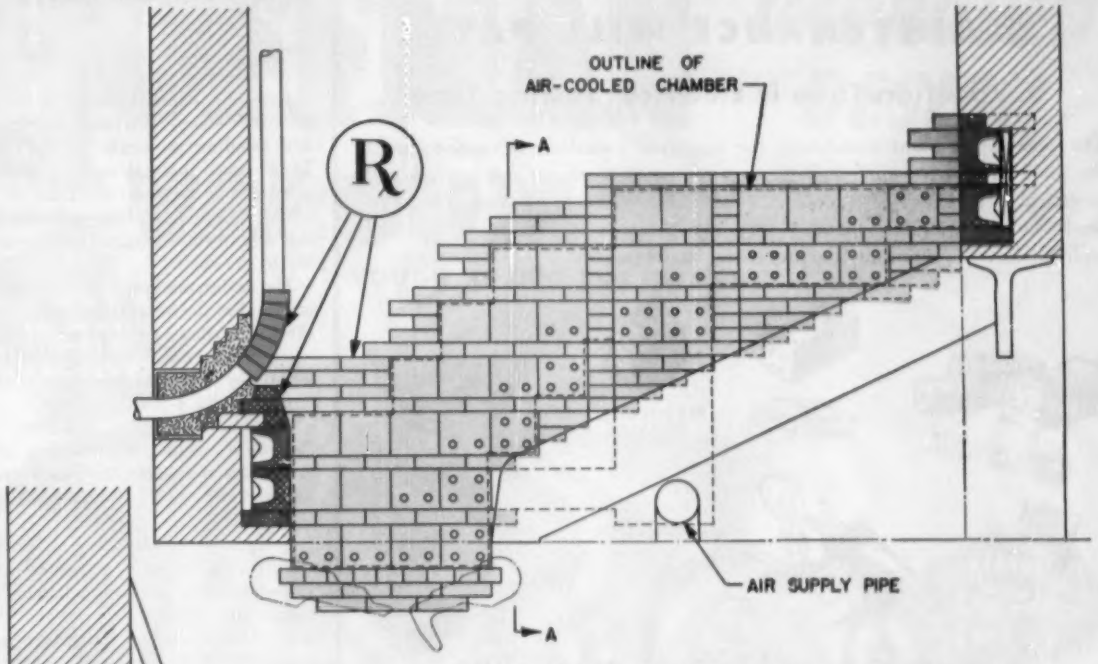

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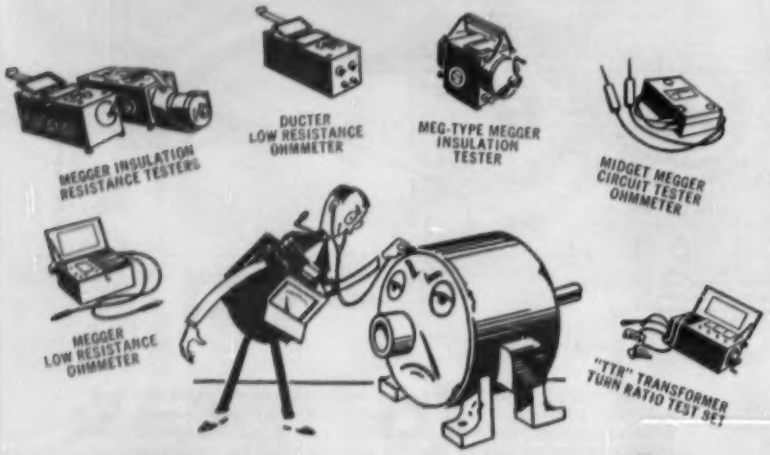
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More TECHNICAL BRIEFS

Begins on page 160

cylindrical shells with the longitudinal axis vertical.

External loads applied to vertical pressure vessels produce axial loading and bending moments on the vessel. These result in axial tensions and compressions in the shell, that must be combined with effects of the pressure loading to give total longitudinal stress acting in the shell.

The design method to be used depends on whether the longitudinal stress in the shell is tension or compression, and on whether the vessel is subjected to internal or external pressure. *ASME paper no. 54-A-104.*

Procedure used for selecting stress values for the ASME Unfired Pressure-Vessel Code. *M D Higgins, Stamford, Connecticut.*

Design and construction of pressure vessels requires safe maximum allowable stress values on which to base their design and determine required thickness of the pressure-containing parts.

The ASME Boiler and Pressure Vessel Code, Section VIII covering Unfired Pressure Vessels, contains rules for the design and construction of pressure-containing equipment. For use in design of such equipment, this Section of the Code contains tables of maximum allowable stress values in tension.

The paper discusses the basis for establishing stress values, source of information on mechanical properties and establishing the stress values. *ASME paper no. 54-A-164.*

Internal-combustion engines

Method of scavenging analysis for 2-cycle diesel cylinders. *By W H Percival, General Motors Corporation.*

In attempting to improve an engine design, if one were to select a new port angle that gave maximum synthetic scavening efficiency without changing any other variable, the result might be (1) a higher pressure drop and therefore a lower scavenging ratio (2) more heat loss during compression due to the effect of swirl on heat transfer, and (3) poor fuel and air mixing resulting in increased smoke and fuel consumption.

These possibilities emphasize need of the engine builder to keep in view the entire engine design when attempting to improve scavenging efficiency, whether by increasing scavenging ratio or by changing port configuration.

Changing the port angle uniformly and in one plane is not by any means

Directions for ordering papers on p 232

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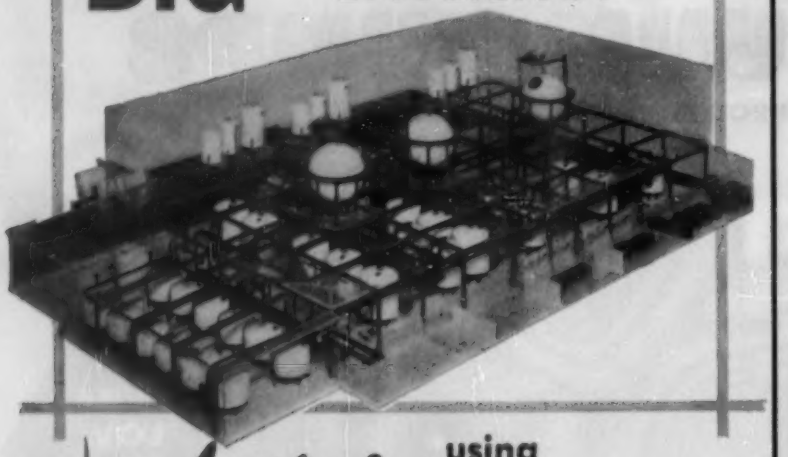

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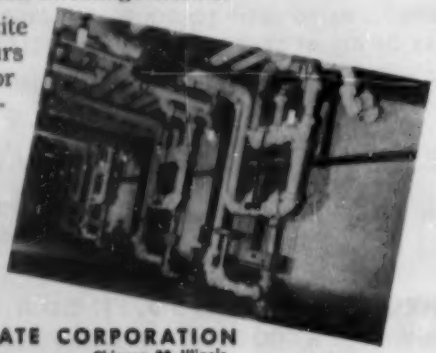

The model grows up. Section of demineralizer plant modeled above—one of world's largest—showing some of automatic control features.

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More TECHNICAL BRIEFS

Begins on page 160

the only solution. For example, several commercial uniflow-engine designs show unsymmetrical port configurations. Compound angles, multiple rows of holes and special deflectors are some other possibilities under study. In addition to scavenging the cylinder efficiently, it is obviously desirable to strive for as much port area and exhaust-valve area as possible and for a maximum flow coefficient. *SAE paper no. 397.*

Engine cranking at arctic temperatures. *By W E Meyer and J J DeCarolis, The Pennsylvania State University, and R L Stanley, Diesel Engine Manufacturers Association.*

To start an engine it must be cranked fast enough to (1) produce a combustible mixture in the combustion chambers (2) develop enough energy to fire the mixture (heat of compression), and (3) enable the engine to develop enough power to continue to fire. Whether or not an engine can be cranked at sufficient speed depends on (1) cranking power available, and (2) resistance to cranking offered by the engine.

For any given engine the resistance to cranking depends largely on the oil viscosity at cranking temperature. This suggests using an extremely low-viscosity oil. But since the same oil must provide adequate lubrication at normal engine operating temperatures, minimum viscosity is dictated by the highest atmospheric temperature that might be encountered during an arctic winter. The military has established this viscosity as 5.75 centistokes at 210 F.

Since this arctic oil became available, field and laboratory tests show that at elevated temperatures oil consumption remains within acceptable limits and that no excessive engine wear occurs. This paper discusses various aspects of the cranking problem investigated during a series of tests with this oil. *SAE paper no. T25.*

Feedwater treatment

Is chemistry in the power plant an exact science? *By Frank Neat, Consolidated Gas Electric Light & Power Company of Baltimore.*

All too often, those not versed in arts of chemistry listen to chemical papers and take as gospel most of the contents. Then, when those who discuss contents of the paper disagree, there is wonder that disagreement could exist over such a simple subject. It is the intent of this paper to show why there is disagree-

Directions for ordering papers on p 232

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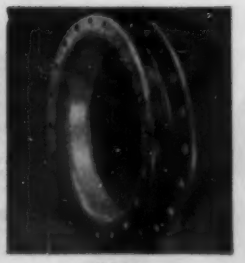

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More TECHNICAL BRIEFS

Begins on page 160

ment and why those versed in the art are entitled to disagree.

The paper concerns itself only with handling and treating water, and steam produced from the water. Other features in which power-plant chemists are interested—combustion, lubrication, surface protection and corrosion—are not discussed.

Items discussed include caustic embrittlement, oxygen scavenging, pitting corrosion, ammonia in the system, alkalinity, hide out and acid cleaning. *ASME paper no. 55-S-38.*

Centralized control of boiler and feedwater chemical treatment at the Valley Steam Plant. *By R C Alexander, W M Hague and Jack Korenthal, Dept of Water and Power, City of Los Angeles.*

This paper describes a sampling and testing arrangement and chemical treatment for two boiler feedwater systems in one central room. They effectively utilize modern automatic chemical control and recording equipment. Centralization of sampling, testing and chemical-treatment facilities for station auxiliary systems is also included.

Based on operating experience at this installation, it is believed there is ample reason to recommend the method used for centralizing plant chemical activities and place control in the hands of trained specialists instead of general plant operating personnel. *APC paper; no number.*

Demineralization of boiler feed makeup for paper mills. *By T J Judge and C L Davis, Jr, International Paper Co.*

Demineralization is fast becoming the most preferred method of treatment of boiler makeup in power plants for the pulp and paper industry. Makeup in these plants approaches or exceeds 40% of the total steam flow.

With the increase in boiler pressures and steam temperatures, water of lower solids concentration is needed for makeup, if blowdown is to be kept within economical limits. This paper discusses five demineralization plants for the pulp and paper industry. Advantages of the various systems are evaluated and specific gains pointed out. *APC paper; no number.*

Treatment of makeup water with a four-bed demineralizing plant. *By Wm M Mayer, Central Power & Light Co, Corpus Christi, Texas.*

Unit No. 1 of Lon C Hill Station includes a 630,000 lb-per-hr steam generator operating at 850 psig and 900 F

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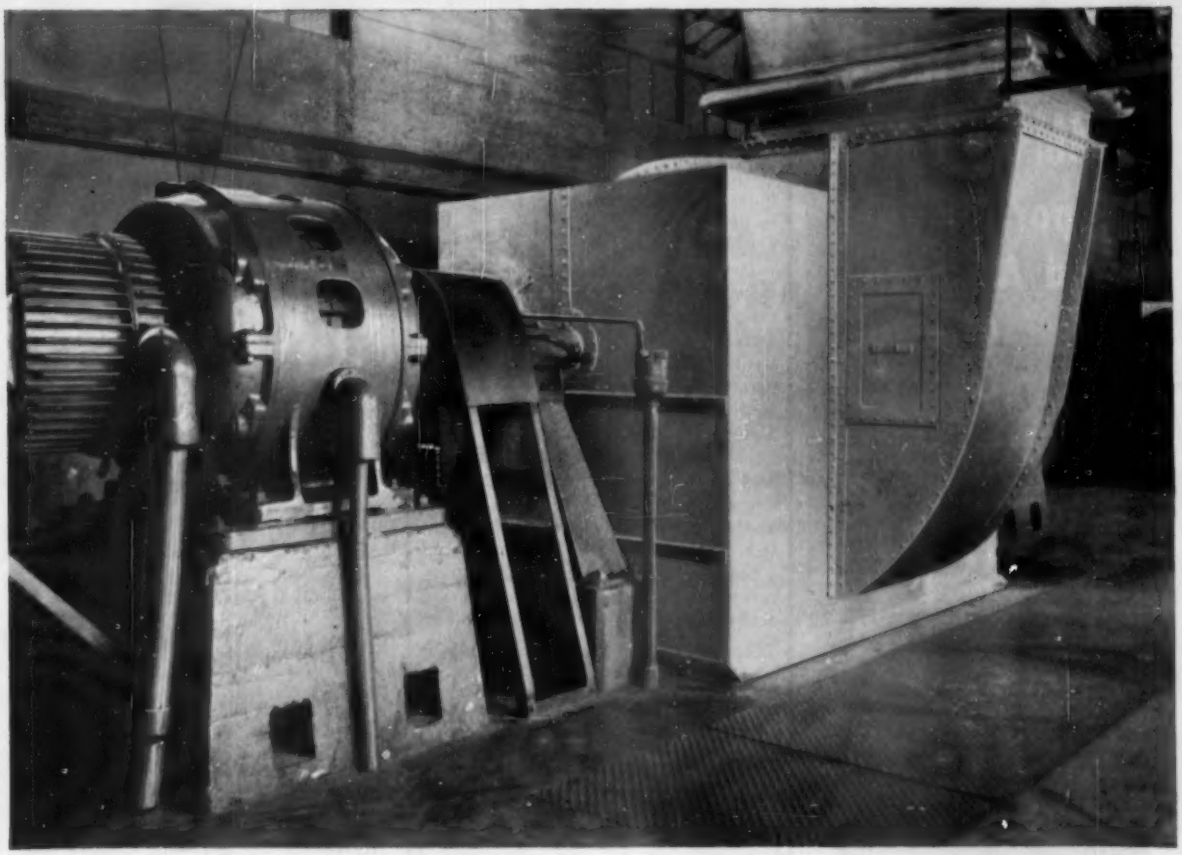

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Begins on page 160

at the superheater outlet. The demineralizer for treating feedwater makeup was sized to provide 1.5% makeup at 100% load factor continuously, if required. Average makeup was expected to be less than 1% with a load factor of 60%.

Provisions were made to double demineralizer capacity by simply adding resin to the exchangers. It will satisfactorily handle Unit No. 2. With the trend toward higher pressures and temperatures, it was thought advisable to obtain equipment that would provide highest possible quality water.

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Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from source, not POWER.

American Society of Mechanical Engineers. Identified by initials ASME and obtainable through ASME, 29 W 39th St, New York 18, New York.

American Power Conference, 17th annual meeting. Identified by initials APC and obtainable through purchase from R A Budenholzer, chairman, Illinois Institute of Technology.

Society of Automotive Engineers. Identified by initials SAE and obtainable through SAE, 29 W 39th St, New York 18, N. Y.

An educational program that will enable college graduates to earn a doctorate in nuclear power while receiving regular industry-scale salaries through on-the-job training has been announced jointly by Westinghouse Electric Corp and the University of Pittsburgh. Under the plan graduates will spend part of their time studying at the University of Pittsburgh and part at Bettis atomic power development laboratory in Pittsburgh. This laboratory is operated by Westinghouse for the Atomic Energy Commission.

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The Permutit Co: Sheller L Steinwender, vice-president. **The Trane Co:** R James Trane, Wayne J Hood, and Thomas J Hancock, executive vice-presidents; Richard H Pearse, Sr, vice-president. **Lunkenheimer Co:** Eibe W Deck, vice-president, production; Earl F Riopelle, vice-president of engineering and research; Chester C Isekeit, vice-president and treasurer.

The Cooper - Bessemer Corp: Fletcher Devin, vice-president. **Stone & Webster Canada Ltd:** Leonard L Youell, vice-president and general manager. **Cleaver-Brooks Co:** Elmer H Wegner, vice-president, manufacturing. **The Babcock & Wilcox Co:** M Nielsen, executive vice-president; L S Wilcoxson, vice-president in charge of boiler div. **Texas Eastern Transmission Corp:** John Clayton Jacobs, Jr, vice-president. **H K Porter Co, Inc:** Laclede-Christy div: C I Young, vice-president and general manager. **Manning, Maxwell & Moore, Inc:** J Robert Kelley, executive vice-president; Chester H Butterfield, vice-president, operations; Charles A Moore, vice-president and treasurer.

SKF Industries, Inc: Edwin R Broden, executive vice-president. **Johns-Manville Corp:** Edward D Flavin, vice-president of Johns-Manville Sales Corp and manager of special industries, industrial products div. **Graybar Electric Co:** Douglas Wallace, vice-president. **Euclid Electric & Manufacturing Co:** C J Rowles, executive vice-president and director. **Research-Cottrell, Inc:** Charles E Beaver, vice-president. **American Bosch Arma Corp:** American Bosch div: Kenneth F Leaman, vice-president, manufacturing; Harold R Sennstrom, vice-president, product development.

Operation executive changes

Link-Belt Co: William A Morley, general superintendent of Philadelphia plant. **U.S. Hoffman Machinery Corp:** Clare F Saltz, manager of ordnance equipment div. **Westinghouse Electric Corp:** Arthur G Tichenor, manager of manufacturing, industrial products div. **Texas Eastern Transmission Corp:** W M Stephens, acting superintendent of construction.

Koppers Co, Inc: Theodore W Chase, manager of coupling dept, metal products div. **The Kerite Co:** L W Eighmy, Jr, manager of power dept. **General Electric Co:** C Howard Black,

Lunkenheimer builds valves to *last*. Back in 1928, a 10-inch Steel Gate Valve was installed in the electric plant in Hamilton, Ohio. After 25 years of steam service at 625°F., the valve was *relocated* on a 725°F. steam line serving a new 10,000 kilowatt turbine generator. *A quarter century of service* — and this Lunkenheimer Steel Valve starts a new job!

This is typical of the dependable service that's built into every Lunkenheimer Valve. Take advantage of Lunkenheimer leadership in design, materials, and workmanship. Specify and use Lunkenheimer Valves — service-engineered for *your* applications. The Lunkenheimer Company, Box 360A, Cincinnati 14, Ohio

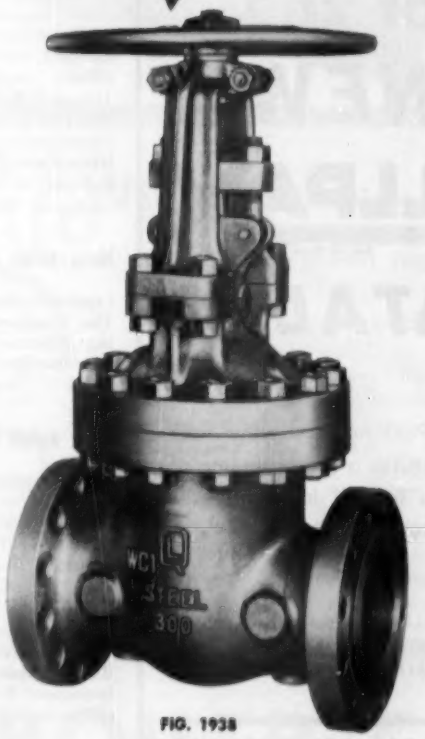

FIG. 1938

The cost of a Lunkenheimer Valve gets smaller and smaller and smaller with each passing year of dependable service.

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WATCH the JULY ISSUE of POWER for PRESENTATION of the NEW ALLPAX CATALOG

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Superheat Sheet Packing . . . Oil Proof Sheet Packing . . . Red Rubber Sheet Packing . . . Diaphragm Sheet Packing . . . Cloth Inserted Sheet Packing.

More APPOINTMENTS

Begins on page 234

general manager of construction materials div; Edwin E Parker, general manager of instrument dept.

Blaw-Knox Co: Thomas J Joyce, works manager of equipment div. **Kuhlman Electric Co:** William T Sackett, Jr, manager of research. **The Cooper-Bessemer Corp:** T M Lamberth, Jr, manager of Shreveport branch office. **Worthington Corp:** J H Loomis, manager of St Louis office.

Engineer changes

Niagara Blower Co: Martin H Olstad, vice-president, engineering. **American Locomotive Co:** Wilson D Leggett, Jr, vice-president, engineering. **The Lincoln Electric Co:** L K Stringham, vice-president, engineering. **Stillman Rubber Co:** Philip B Keller, vice-president, engineering.

Mathis Water Treating Co: Harry M Spring, Jr, chief engineer. **Link-Belt Co:** Dwight H Renfrew, chief engineer. **Wheeling Steel Corp:** Carl D Burkland, chief industrial engineer. **Cobell Industries, Inc:** George A Chappell, Jr, chief engineer.

General Electric Co: Arthur H Sisson, manager of advance engineering, small turbine and supercharger dept. **Edward Valves, Inc:** Wallace A Altgilbers, chief time study engineer; Thomas E Rost, chief draftsman. **ACEC Electric Corp:** Robert W Baldwin, headquarters application engineer. **Blaw-Knox Co:** A H Jackson, general manager of engineering and development dept, equipment div.

New sales vice-presidents

Lunkenheimer Co: Melvin W Pauly. **The Foxboro Co:** C C Fuller. **Sterling Electric Motors, Inc:** John R Howell. **The Hays Corp:** Orval W Riggs.

New sales managers

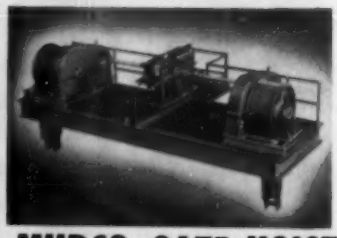
Delta Heating Corp: William T Goldsmith, national sales. **The Foxboro Co:** H O Ehrisman, general sales; J J Burnett, field sales. **Blaw-Knox Co:** Robert A Troman, tower dept, equipment div. **Childers Manufacturing Co:** John C LaFave, jacketing sales. **Warner Electric Brake & Clutch Co:** John Dewey, Chicago branch. **Burgess-Manning Co;** Penn Industrial Instrument div: William F Braun, Eastern region.

New representatives

For **Continental Foundry & Machine Co:** Copes-Vulcan div: The Hesler Co, 1233 Dierks Bldg, Kansas City 6, Mo. For **Sarco Co, Inc:** Hoffman & Hoffman Co, with offices in Greensboro, N. C., Raleigh, N. C., and

When you plan...

POWER DAM GATES



MURCO GATE HOISTS
for any Size Power Dam

ask us about design and patterns that may help you . . .

In planning gates or gate hoists, you may save time and money if you will write us before your over-all plans are complete . . . In over seventy years of designing and building power dam gates and gate hoists, we have developed designs for many gate and gate hoist problems. For that reason, we may have designs and patterns that will fit your special requirements. MURCO gate hoists are designed and built in a wide range of capacities, from less than one ton to over one hundred tons . . . from the smallest hand operated to the largest motor operated gate hoist.

We also build gate hoists to fit your plans and specifications. Write for complete information and Engineering Department recommendations.

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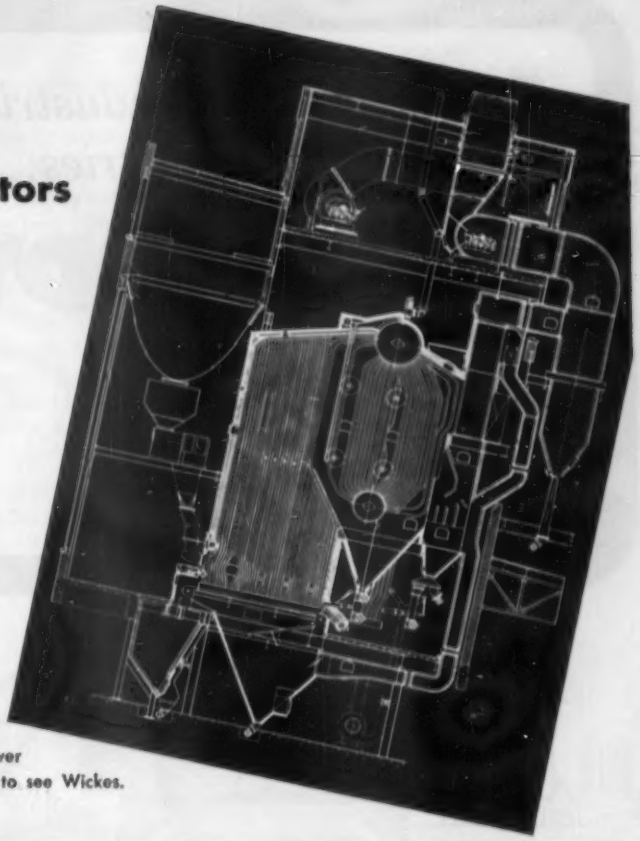
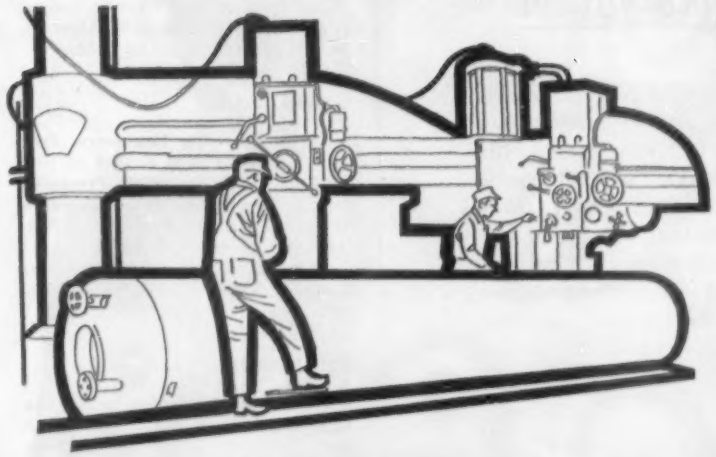
WICKES

dependable steam generators for supplying heat and power in every kind of installation



Modern industry's need for heat and power doesn't come ready-made for a certain type or size of steam generator. Every installation is different. That's where the highly varied experience and extensive facilities of the Wickes Boiler Co. pay off for you in more dependable installations. Wickes engineers will design and build you a steam generator that is specifically suited to your purpose; one that will assure you of fine service for years to come, whether your installation is large or small, whether it's a schoolhouse or an atomic energy plant. Whatever the nature of your steam generator needs, it will pay you to see Wickes.



WICKES complete facilities for custom metal fabrication to exact specifications

When a company has been fabricating heavy-gauge metal assemblies for as many years as Wickes, and has built such a fine reputation for dependable products, it follows that all those skills and facilities can help you a great deal on custom fabricating jobs. We have the laboratories, the production equipment, and the inspection service to do the same excellent work for you that we do for ourselves. For exacting custom metal fabrication, write us about your requirements.

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THE WICKES BOILER CO.

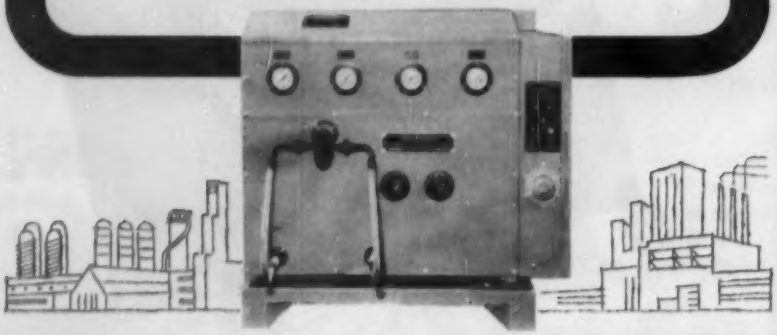
DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

RECOGNIZED QUALITY SINCE 1854 • SALES OFFICES: Albuquerque, N. M. • Boston • Buffalo • Charlotte, N. C. • Chicago • Cleveland • Dallas • Denver • Detroit • Fort Wayne, Ind. • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • Portland, Ore. • Saginaw • Salt Lake City • San Francisco • Springfield, Ill. • Tampa, Fla. • Tulsa • Washington, D. C.

Designed for all industries
used in all industries...

the **PEABODY PK-54**

AUTOMATIC BURNER



for oil, gas, or combination

The Peabody PK-54 Burner has achieved full recognition throughout industry as an *efficient, safe, dependable* unit for any boiler application. Completely factory assembled with integral forced draft fan — *fire-tested* and calibrated before shipment, the PK-54 cuts installation time, saves space and holds manpower requirements to a minimum. Sized for boilers up to 42,000 lbs. steam per hour. With complete combustion sequence, safety and interlock controls, the PK-54 is the modern answer to industry's need for lower costs plus dependable, economical performance.

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DAIRIES	PLASTICS	AND MANY OTHERS . . .

Complete details of how Peabody's PK-54 can fit your combustion requirements available on request.

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B-164

More APPOINTMENTS

Begins on page 234

Columbia, S. C. For **Cleaver-Brooks Co:** Delval Equipment Corp, 4610 N 15th St, Philadelphia, Pa.

For **R E Uptegraff Manufacturing Co:** Virgil Marshal, 922 N Audubon Rd, Indianapolis, Ind.; Benson, Funk & Associates, 1357 Washington St, Newton, Mass.; W W Jackson, Southbury, Conn.; Eads Co, Dunlavy St, Houston, Texas; Commercial Engineering Co, 1627 K St, NW, Washington, D.C.; Moreland Engineering & Sales Co, N Duke St, York, Pa.; and Griffin & Griffin, 931 W Peachtree St, NE, Atlanta, Ga. For **Hammel-Dahl Co:** Russell F Clark Co, 1404 Clark Bldg, Pittsburgh 22, Pa. For **Edwin L Wiegand Co:** Harold Miles & Associates, 424 Georgia Ave, Chattanooga 2, Tenn.

For **Barber-Colman Co:** Wheelco Instruments div: R H Wittbold Co, 1951 Richmond Ave, PO Box 6061, Houston 6, Texas. For **Bulkley, Dunton Processes Inc:** H E Danby Co, Inc, Indianapolis, Ind.; Nicholas A D'Arcy, Jr, Huntington Park, Calif.; W H Davidson Co, Wayne, Pa.; and John D Homan, Tampa, Fla. For **Electric Regulator Corp:** E L Berman Co, San Francisco, Calif.

For **Hapman-Dutton Co:** Bushnell Controls & Equipment Co, Inc, 4383 Piedmont Ave, Oakland, Calif. For **Childers Manufacturing Co:** John P Dobbins Co, Tulsa, Okla.; Fred G Greaves Co, 3215 Western Ave, Seattle, Wash.; Pace-Turpin Co, 726 S Third West, Salt Lake City, Utah; Vernon Hines, PO Box 4148, S Denver Station, Denver 9, Colo.; and D M Allen Co, 3021 Main St, Kansas City 8, Mo.

Recent moves

Lockwood Greene Engineers, Inc: New York office to 41 E 42nd St, New York 17, N. Y. **Assembly Products, Inc:** to Chesterland, Ohio. **Sauerman Bros, Inc:** to 620 S 28th Ave, Bellwood, Ill. **Stephen C May:** to 3551 Ivy Rd, NE, Atlanta, Ga. **Norton Co:** Los Angeles office to 5905 Pacific Boulevard, Huntington Park, Calif.

Retirements

C Harold Berry, Gordon McKay professor of mechanical engineering at Harvard University and former associate editor of POWER.

William V Drake, vice-president of West Penn Power Co, after 34 yrs service.

Obituaries

W A Roberts, 57, president of Allis-Chalmers Manufacturing Co, April 12th.

Beauford H Reeves, 63, president of Rockbestos Products Corp, April 1st.

Samuel G Dunning, 63, service consultant of Reliance Electric & Engineering Co, March 16th.

Blowdown

WAS THE PROBLEM

Boiler blowdown, an important engineering consideration, is one of the numerous details thoroughly investigated by the Drew engineer when he makes a plant survey.

Take the recent case of a West Coast Oil refinery, for many years troubled by intermittent carryover and boiler sludge deposits. The Drew man was called in for consultation and advice.

A comprehensive plant survey revealed that improper location of internal continuous blowdown piping in the boilers, was causing sludge build-up and high solids concentrations.

Complete operating details were submitted to the Drew Technical Service Department, and specific recommendations were made which included the proper sizing and location of continuous blowdown piping, as well as boiler water concentration controls; a clear-cut case of a problem solved through engineering.

Why not take advantage of Drew experience in all matters relating to boiler feedwater treatment? Send for our booklet, "Complete Boiler Water Treatment"—no obligation, of course.

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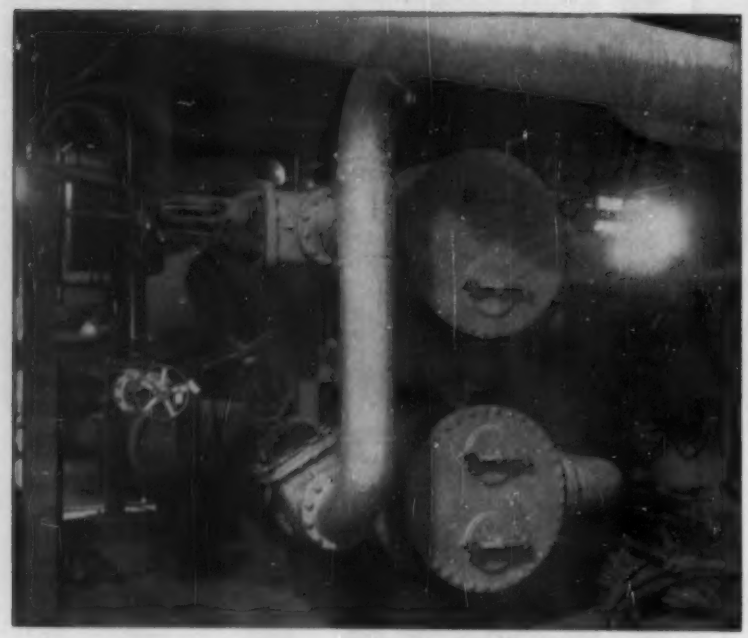
"North Omaha" looked beyond "price" and "delivery date".....



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Of course, price and delivery counted. But North Omaha Power Plant, which bought two 4000 sq ft. Conseco Service Water Coolers got some very important extras in low operating cost and economical maintenance. Conseco design engineers work in coordination with our service engineers who have specialized for over a quarter century in rebuilding, retubing, modernizing, and maintaining all types of tubular equipment including competitors' makes. This assures unusually low cost maintenance and operating economy for Conseco equipment.

Send for bulletin showing features of Type AL Conseco Oil and Water Coolers.

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Conseco maintenance division has been repairing, rebuilding, modernizing, and maintaining equipment used in power, chemical, refining, and marine industries for over a quarter century. Our highly mechanized field crews are supervised by qualified engineers and backed by specialized manufacturing facilities and ample replacement parts. Thus you are assured of fast, efficient results at lowest cost. Conseco service is as near as your phone.

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BOOKSHELF

Steam—Its Generation and Use. *(37th edition, 1955) Prepared and edited by engineers and specialists within the Babcock & Wilcox Company. 8½x11¼, 558 pages of text, illus, tables, graphs. Cloth, $10.00. The Babcock & Wilcox Co, 161 E 42nd St, New York 17, N. Y.*

The long awaited 37th edition of *Steam* is now available. And it is well worth the wait. This newest edition has valuable information for mechanical engineers and mechanical engineering students alike. As in previous editions, the first of which appeared in 1879, all the material was prepared and edited by engineers and specialists of the Babcock and Wilcox Company.

Introduction covers early history of the steam engine and the development of steam generators. Later chapters deal with sources of heat energy, principles of combustion, fans and draft, temperature measurement, heat transfer, fluid dynamics, boiler circulation, and steam and other energy cycles. Other chapters cover the care, manufacture, installation and selection of boilers. Chapters on superheat temperature adjustment and control, various heating and reclaiming surfaces in boilers, settings, insulation and casings, firing equipment, waste heat recovery and metallurgy are also included. There are separate chapters on research and development, nuclear power, the cyclone furnace and marine uses.

Throughout the book there is a wealth of information on basic as well as specific design considerations. It makes an excellent study book for the mechanical engineering students in the applied thermo field as well as providing a good reference book for engineers in practice. Past editions of this book have been accepted as text books in college mechanical engineering courses throughout the country. This newest edition should be no exception.

Pipe Friction Manual. *Prepared by the Hydraulic Institute. 87 pp, 8½x11, illus, tables, paper, $1.75. Hydraulic Institute, 122 E 42nd St, New York 17, N. Y.*

Material in this manual is an extension and rearrangement of pipe friction data contained in the earlier "Tentative Standards of the Hydraulic Institute—Pipe Friction." Data presented are latest available and they follow a pattern developed from suggestions given by users of the earlier publication.

Complete tables of friction loss for water are presented. Wrought iron, steel and cast iron pipe in sizes from ⅛ through 84 in. diameter are covered. Tables give resistance coefficients for valves, fittings, bends, diffusers, etc.

Full-page charts for friction loss for incompressible flow of various fluids have been redrawn for greater clarity. Also included are three fold-in charts of friction factors with related data to permit calculation of friction loss for any fluid in any size or shape conduit.

Of particular utility are numerous examples showing solution of pipe-friction problems. These have been checked and clari-

Performance-- Value...

FIG. 16003—600-Pound Steel Pressure Seal Gate Valve.

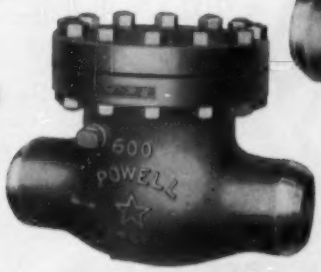

FIG. 6061 WE—600-Pound Stainless Steel Swing Check Valve.

. . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . .

FIG. 3003 WE—Steel Gate Valve for 300 Pounds W.S.P.

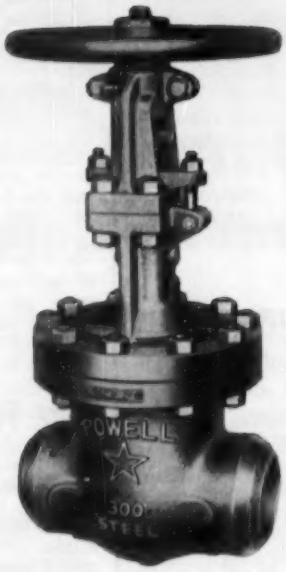

FIG. 1793—Iron Body, Bronze Mounted, Gate Valve For 125 Pounds W.P.

Powell Valves

You can depend on outstanding *performance* from every valve made by The Wm. Powell Company, for Powell Valves have a proven record of long life and dependable service.

And Powell Valves give you better *value!* They're precision made and incorporate many quality features—features that can save you money and give you lasting flow control.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our *COMPLETE quality line*, and help solve any flow control problem you may have.

The Wm. Powell Company, Cincinnati 22, Ohio . . . . . 109th year

the best is easiest to buy..

AJAX
SPIRAL WOUND GASKETS
are Sold Nationally through
INDUSTRIAL DISTRIBUTORS

FOR LOWER PRESSURES

Type "H" Ajax Spiral Wound Gaskets with integral wire centering guide answer the demand for a low-priced self-centering ring gasket. Permit the use of the smallest, least-expensive gasket for maximum sealing effect. For pressures up to 600 psi.

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Type "S-R" Ajax Spiral Wound Gaskets with solid metal reinforcing ring which locates gasket inside bolt circle, prevents lateral expansion under pressure and acts as a compression gauge for maximum gasket efficiency. For pressures up to 1500 psi.

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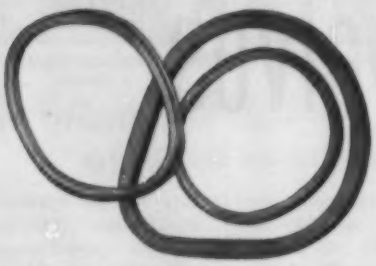

Ajax Spiral Wound Gaskets are offered in all sizes and shapes for manholes, hand holes, tube caps, etc., for all standard makes and models of boilers, water walls, economizers and other boiler accessories.

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FABRICATORS OF FLUOROCARBONS AND OTHER PLASTICS

Representatives in principal cities throughout the world

More BOOKSHELF

Begins on page 240

fied to the point where the volume has become not only an essential tool for engineers but it is also an excellent text for college instructors and students.

Plant and Process Ventilation. *By W C L Hemeon, engineering director, Industrial Hygiene Foundation of America, Inc, Mellon Institute. 437 pp, 6x9, illus, tables, cloth, $9.00. The Industrial Press, 93 Worth Street, New York 13, N. Y.*

This book differs from others on ventilation in that emphasis is placed on estimating ventilation quantities required in various industrial situations, while duct design, a well understood technique, has been simplified by condensation of design data. This frees the engineer of unnecessary detail.

Data provides the engineer, as well as the student, with design factors for any situation found in a plant. This is accomplished by a new but widely used system of classification embracing all ventilation situations.

Subjects covered include objectives, contaminants, dispersion, local exhaust, hoods, materials handling systems, air jets, duct design, exhaust systems and fans.

Flak's Graphical Solutions to 100,000 Practical Problems. *Prepared and edited by Karl H Kalk. 419 pp, 6x8½, illus, cloth, $6.00. Columbia Graphs, Columbia, Conn.*

This is a collection of intersection charts and graphs for solution of simple problems in the fields of mechanics, hydraulics, electricity, construction, physics, chemistry, agriculture, medicine, mensuration, trigonometry, weights and measures. It should prove useful to engineers having direct need for the solutions presented.

While the charts save time in solving specific problems, it must be remembered that the equation on which the chart is based must be suitable for conditions being considered. This would require that the reader becomes familiar with the contents of the section he intends to use, before he starts solving problems. With so many charts available in one volume, most engineers will find some useful on the job.

More POWER NEWS

Begins on page 158

Gas turbine (*cont from p* 158)

since maximum allowable operating conditions were reduced to 5400 rpm and 1250-F turbine inlet temperature.

Coal-burning tests were resumed in June, after a series of preliminary runs had revealed excessive generator vibration existed at all turbine speeds above 4500 rpm. Rather than spend additional time on balancing to run at higher speeds, it was decided to run the 1954 tests at this speed. By Sept, 300 hours of coal-fired operation had been completed. The turbine was opened for in-

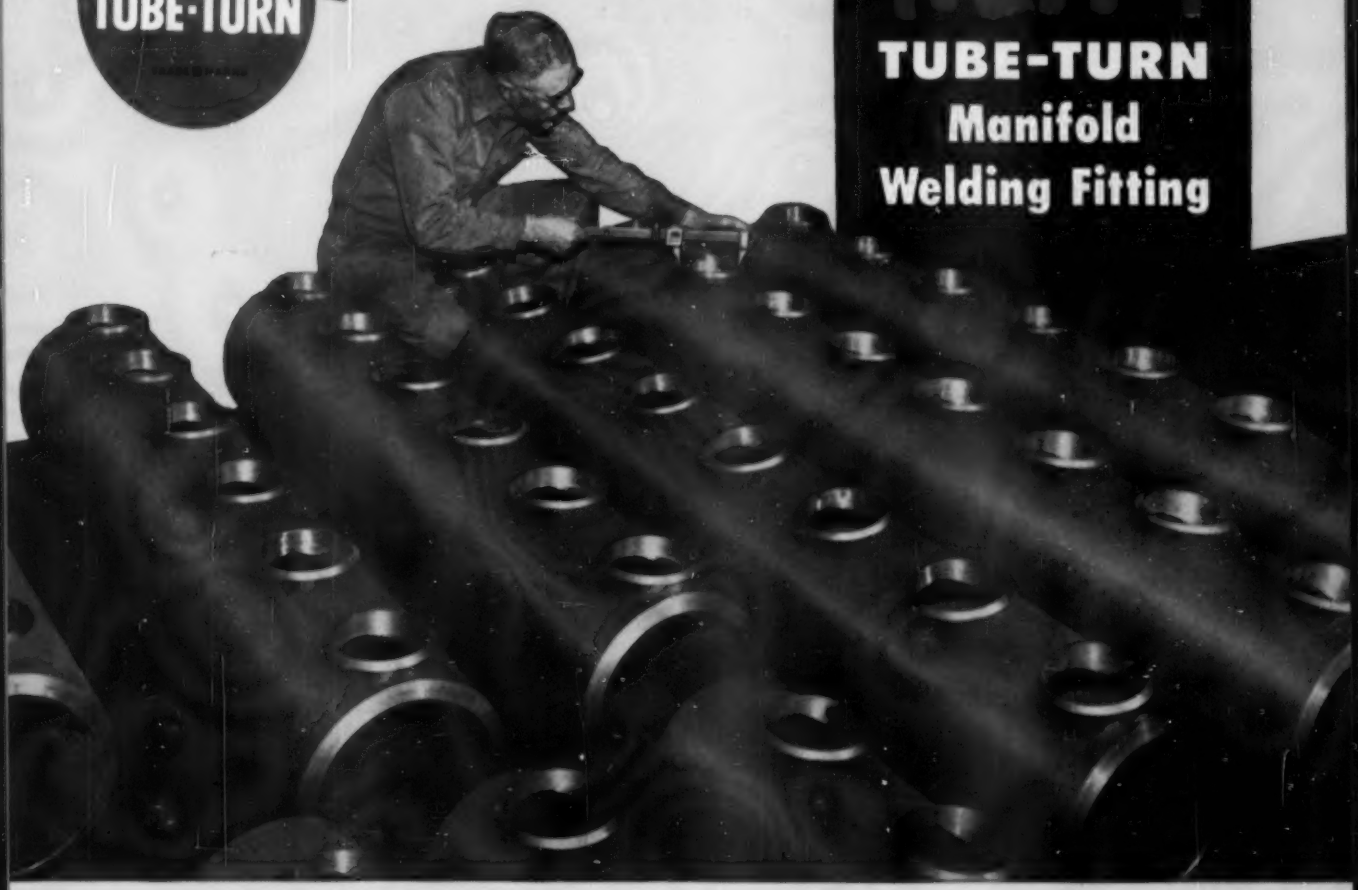
(*Continued on page* 246)

tt
TUBE-TURN

Remember the trademarks "tt" and "TUBE-TURN" are applicable only to products of TUBE TURNS.

NEW!

TUBE-TURN Manifold Welding Fitting



simplifies piping construction, reduces costs

TUBE TURNS now offers custom-made Manifold Welding Fittings with size, wall thickness, and number of outlets as required by your service conditions. These manifold fittings are available in all commercial metals and alloys.

Use of TUBE-TURN* Manifold Welding Fittings provides stronger and safer outlet connections than are possible when pads and saddles are employed. This new fitting makes possible greater economy and speed of construction in many types of service. It is particularly useful when outlets are smaller than one-half the run pipe diameter, when they are extremely close together, or when they must vary in size.

This new addition to Tube Turns' line enables you to "specify TUBE-TURN" for all your tee and manifold fitting requirements. For prompt, helpful service, get in touch with your Tube Turns' Distributor. You'll find one in every principal city.

The new TUBE-TURN Manifold Welding Fitting . . . superior to pad and saddle construction . . . easy to install . . . dependable in service.

TUBE-TURN Welding Fittings and Flanges are made in U.S.A.
They meet *all* U. S. piping code specifications

*"TUBE-TURN" and "tt" Reg. U. S. Pat. Off.

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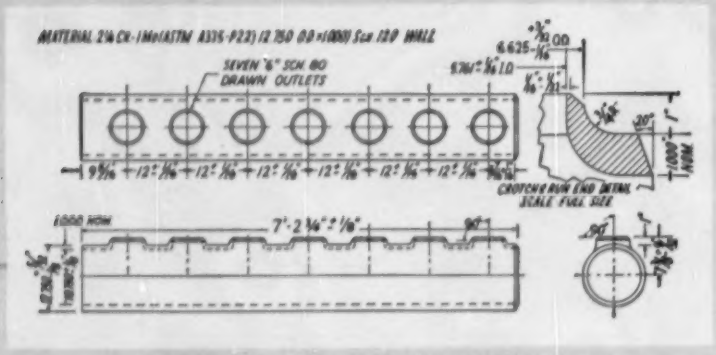
APPLICATIONS

Why TUBE-TURN Manifold Welding Fittings give you safer service

In conventional pad and saddle construction, the transition to the side section of the branch is abrupt, creating stress concentration, often leading to failure. The TUBE-TURN* Manifold Welding Fitting with *integral extruded outlets,* is superior in strength. It provides a smooth transition from the pipe run to the smaller, thinner-walled outlets, and is thus better able to withstand cyclic stress from pressure or temperature changes.



12" Manifold with Seven 6" Outlets. Schedule 80.

TUBE-TURN Manifold Welding Fitting being installed in a measuring station of a large west coast gas utility.

CODE APPROVED

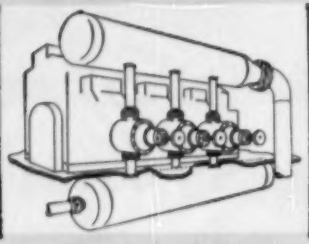
TUBE-TURN Manifold Welding Fittings are in full accordance with the latest recommendations of ASA B31.1 Subcommittee No. 8.

TUBE-TURN Manifold Welding Fittings comply with the requirements of ASA B16.9 and ASTM A234 covering the design and manufacture of butt welding fittings.

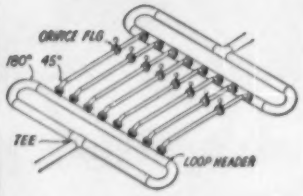
TYPICAL APPLICATIONS

TUBE-TURN Manifold Welding Fittings can be used in virtually all types of major piping systems. Tube Turns' Sales Development Department will be glad to assist you in application problems.

Pipe Still or Charge Heater



Compressor Station Suction and Discharge Headers



Meter Run Loop Header

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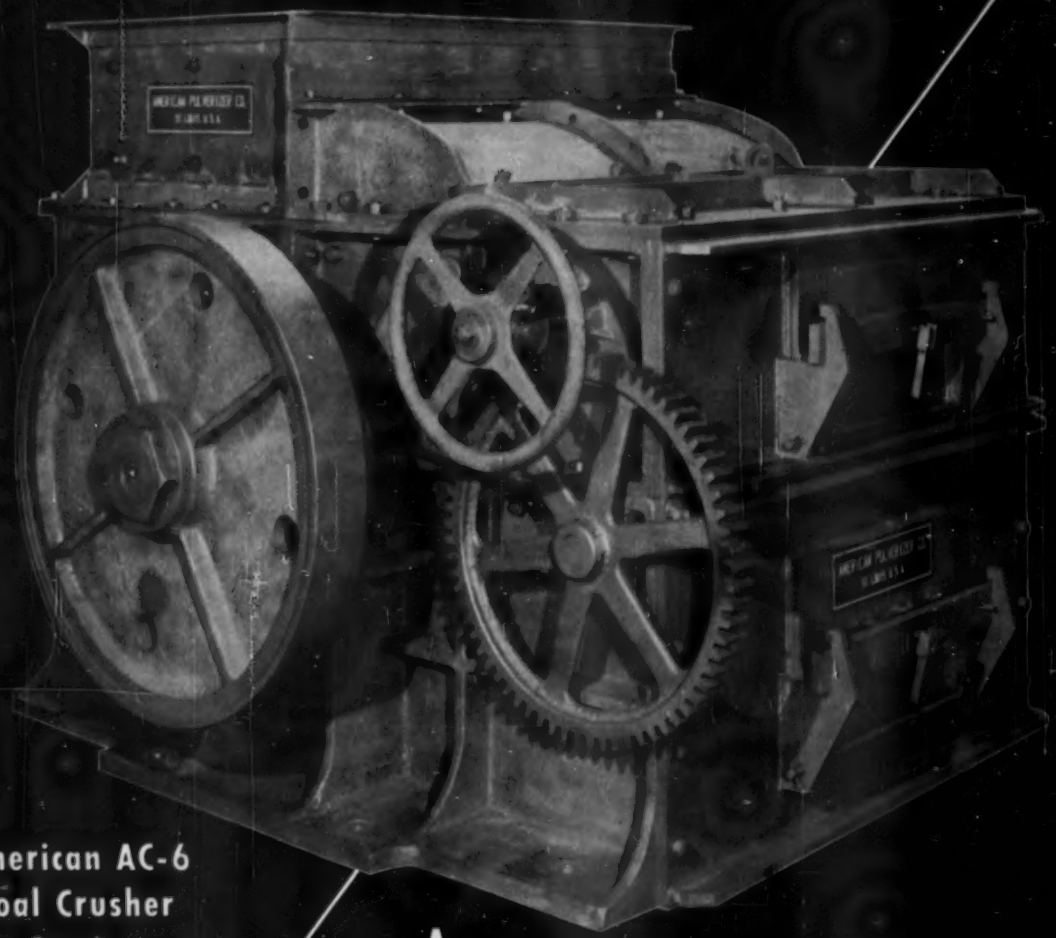

American AC-6 Coal Crusher

Capacity: 300 tons per hr. ROM to 3/4"

American Crusher quality is being constantly reaffirmed by case histories coming in from power plants, central stations and mines throughout the country . . . records which are proving beyond a doubt American's superlative performance and economy of operation. Here, for example, are the

Cost Surveys of 29 American Installations

Total Tonnage Handled.....61,000,000 Tons
Average Age of Crushers.....9.5 Years
Replacement Parts (Includes Standby Parts).....1/10 of 1¢ per Ton

THERE CAN BE NO BETTER PROOF OF QUALITY!

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

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Tired of getting "the treatment" from water treatment pumps?
Here are 4 points for trouble-free proportioning
COMPLETELY ENCLOSED
ADJUSTABLE WHILE IN OPERATION
OIL-BATH OPERATION
BUILT-IN PRESSURE RELIEF
"K-3" pump handling phosphate and sodium sulphite.

HILLS-McCANNA "K" Type Hydraulic Drive Pump

In the Hills-McCanna "K" Type proportioning pump, working parts operate in a bath of lubricating oil which also serves as hydraulic fluid. This unique in-line, direct acting hydraulic drive system is the result of long experience in the solution of problems peculiar to boiler feed water treatment applications. Ordinary pump maintenance and service problems involving vertical type liquid ends, exposed linkage and linkage lubrication . . . linkage and drive misalignment are eliminated.

Hills-McCanna "K" Type pumps are available in one and two feed units in capacities up to 726 gph per feed. "Packaged units," suitable for phosphate or sulphite treatment, are also available.

Write for Bulletin KP-54. HILLS-McCANNA CO., 2369 W. Nelson St., Chicago 18, Ill.

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metering and proportioning pumps

Also Manufacturers of-
SAUNDERS TYPE DIAPHRAGM VALVES
FORCE FEED LUBRICATORS • MAGNESIUM ALLOY SAND CASTINGS

More POWER NEWS

Begins on page 158

spection. Blades were found to be free from both erosion and ash deposits, indicating that the new separator has done a satisfactory job of protecting the turbine.

Decision was made to conduct further tests toward the goal of operating continuously at high load. The turbine was reassembled and generator unbalance corrected to permit operation at 5400 rpm. Coal burning began on a single-shift basis in Jan 1955. Three-shift operation was begun in Feb and continued for three weeks until the plant was closed by a strike. During Feb, 180 hours of high-load operation were accumulated, including continuous runs of 12, 13, 31 and 53 hours. Operation resumed after three weeks' delay, and 233 additional hours were added, including individual runs of 22, 27, 16, 41 and 44 hours. The average load for the 1955 operation was 3280 hp, 92.6% of rated capacity. When accessible portions of the first row turbine blades were inspected in Apr, no measurable erosion could be seen, nor were any ash deposits observed.

Lighting system (*cont from p* 158)

tion of 490 eight-foot slimline fluorescent lamps on 400-cycle power. Increasing frequency to 400 from standard 60 cycles is accomplished by means of two 30-kw rotating-type package-unit frequency converters.

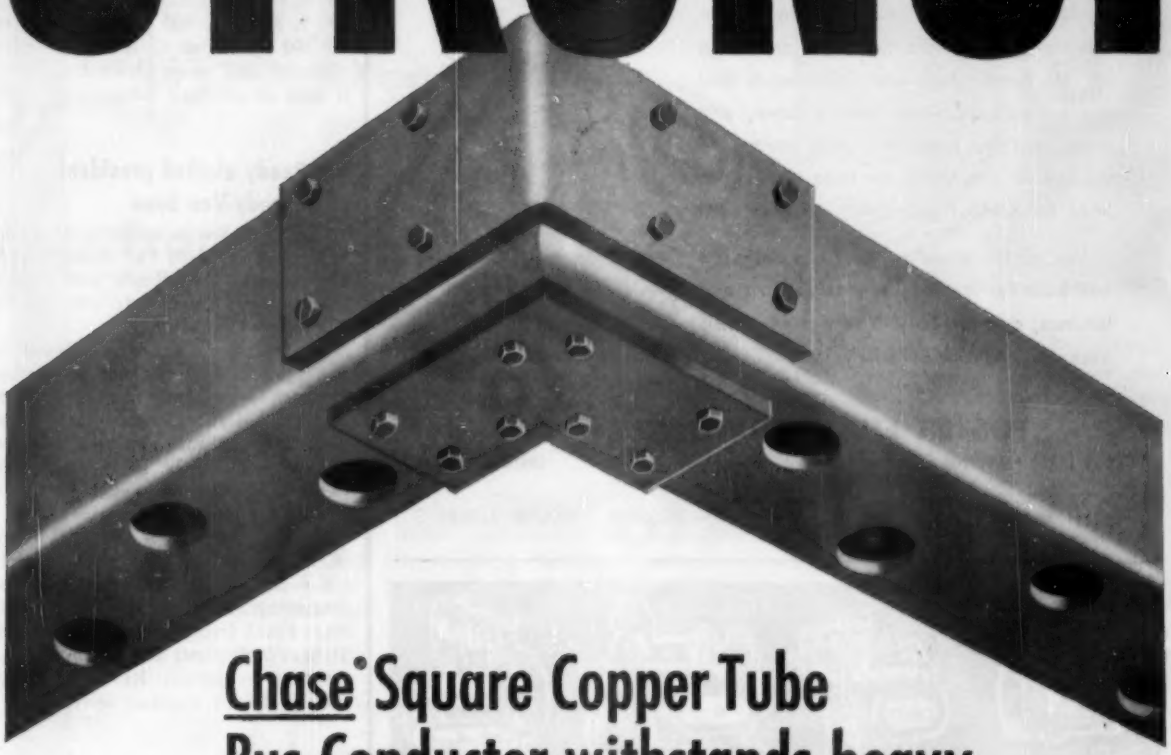
Chief benefit of the system is that it represents the most economical method yet devised for obtaining higher levels of light in high-bay areas, according to John H Campbell, GE illuminating engineer who conceived and developed the technique. The system cost approximately 10% less to install than an incandescent-mercury lighting system originally considered for the field house. In addition, the 400-cycle system offers an estimated 50% savings in annual operation and maintenance costs while producing 20% higher levels of light.

The fixtures, designed by Carl J Allen, GE school and indoor sports lighting specialist, were made by Curtis Lighting, Inc, of Chicago. Largest fixtures ever used for high-bay lighting, they are 8-ft sq, but weigh considerably less than would comparable fixtures in conventional lighting installations. Each fixture contains 14 slimline lamps.

Lighting fixtures are mounted at heights varying from 60 ft in the center to 34 ft on the sides. Each lamp produces 6000 lumens. The entire lighting job produces about 3-million lumens.

The lighting layout is so arranged that each of the two rotary converters

STRONG!



Chase® Square Copper Tube Bus Conductor withstands heavy short circuit stresses, minimizes sag!

The square cross section configuration of Chase Ventilated Square Copper Tube Bus Conductor gives it the extra strength needed to withstand the stress of heavy short circuits . . . to permit longer spans between supports!

The heat-dissipating vent holes in Chase Bus Conductor that increase current-carrying capacity up to 20% *also* save you as much as *36%* in weight of copper in comparison with flat rectangular bus bar!

For full information about Chase Ventilated Square Copper Tube Bus Conductor, send for the free Chase Bus Conductor Brochure.

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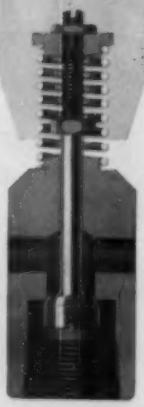

Foster makes a complete line of spring loaded automatic valves for use in vacuum service — with simple types for protection of stills, heater shells and similar equipment against collapse when cooling down, and more sensitive types for close control of vacuum in manifolds, air lines, and vapor lines for various processing requirements.

Like all Foster valves, they are designed and built for long life with minimum maintenance, and are easy to service when it is necessary. Ask for Bulletin V-101.

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FRICK CO.
Open-drive Low Pressure Units
Large 2-Cyl.
Large 4-Cylinder

More POWER NEWS

Begins on page 158

operates the lamps to allow for approximately equal distribution of light. A simplified wiring system reduces the number of circuits from 84, for the lighting method originally considered, to 14 for the high-frequency design.

Primary power source is 208 v, 3 phase, 60 cycles, and the secondary is 600 v, 3 phase, 400 cycles, connected for 300 v to ground. A simple series capacitor and series choke for ballast is used on alternate lamps.

F O Reedy elected president of Kennedy-Van Saun

► AT THE ANNUAL MEETING of stockholders of Kennedy-Van Saun Mfg & Engrg Corp, F O Reedy was elected president. J E Kennedy was elected chairman of the board.

Reedy joined Kennedy-Van Saun in 1920, previously serving as production engineer for the American Car & Foundry Co. His work has taken him throughout the world, including a three month stay in Russia. He is particularly well-known for his connection with Army-Navy Ordnance requirements.

Besides Reedy and Kennedy, other officers elected at the annual meeting were: Byron Pyle, executive vice-president; Maurice Shafer, vice-president; Frank Irving, secretary-treasurer; Thomas McDermott and R M Kennedy, assistant treasurers; Ray Safian and John H Bausch, assistant secretaries.

Advisory committee named for Chicago power exposition

► ANNOUNCEMENT HAS BEEN made of the advisory committee for the Chicago Exposition of Power and Mechanical Engineering, scheduled for the Chicago Coliseum, November 14 to 18. The event is to be held under the auspices of the American Society of Mechanical Engineers in conjunction with its Diamond Jubilee anniversary meeting.

Named chairman of the committee is I E Moultrop. John H Lawrence is vice-chairman. Membership includes:

Leon Buehler, Jr, president, ASRE; Chester R Earle, executive editor, "Power Engineering"; M J Goglia, professor, school of mechanical engineering, Georgia Institute of Technology; J E Haines, president, ASHAE; K M Irwin, vice-president, engineering, Philadelphia Electric Co; C E Morrow, Western Electric Co; George A Orrok, Boston Edison Co; Joseph Pope, vice-president, Stone & Webster Engineering Corp; C J Sibler, West Virginia Pulp

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by steam, diesel, or hydro-electric plants are all within the scope and experience of Kaiser Engineers' diversified team of engineering specialists.

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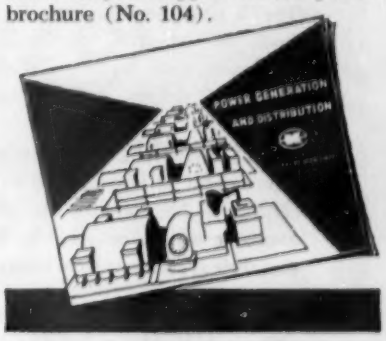
Write for your copy of the KE power brochure (No. 104).



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BUELL ENGINEERS will submit samples of your dust to their laboratories for analysis...make an on-the-spot check of your operating conditions. They will then tell you exactly what percentage of stack discharge will be collected by Buell equipment. The records show that their predictions have been amazingly accurate!

For More Facts...
write for booklet: The Collection and Recovery of Industrial Dusts, which explains *all three* Buell Systems. Dept. F-50, Buell Engineering Company, 70 Pine Street, N. Y. 5, N. Y.

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More POWER NEWS

Begins on page 158

& Paper Co; A Bowman Snavely, Hershey Chocolate Corp; Philip W Swain, consulting editor, POWER.

Early reservations of exhibit spaces assure a representative display of equipment covering every phase of power generation and industrial use. The exposition is being managed by International Exposition Co, 480 Lexington Ave, New York 17, N. Y.

Calendar of Events

June 5-8—American Boiler Manufacturers Assn & Affiliated Industries, 67th annual meeting. Skytop Lodge, Skytop, Pa. Details from ABMA&AI, 1571 W 117th St, Cleveland 7, Ohio.

June 7-10—American Welding Society, national spring meeting. Hotel Muehlebach, Kansas City, Mo. To be held in conjunction with annual Welding Show at Municipal Auditorium, Kansas City, on June 8-10. Details from AWS, 33 W 39th St, New York 18, New York.

June 13-16—Edison Electric Institute, 23rd annual convention. Los Angeles, Calif. Full information from EEI, 420 Lexington Ave, New York 17, N. Y.

June 13-17—The American Association for the Advancement of Science, Gordon Research Conference on ion exchange. Full information on request to W George Parks, director, dept of chemistry, University of Rhode Island, Kingston, R. I.

June 13-17—National Association of Power Engineers, Inc, 73rd annual convention, Hotel Waldorf-Astoria, New York, N. Y. Details from NAPE, Room 755, 301 Park Ave, New York 22, N. Y.

June 14-16—American Institute of Electrical Engineers, in cooperation with American Physical Society and American Institute of Mining and Metallurgical Engineers, 1st magnetics conference and exhibition. William Penn Hotel, Pittsburgh, Pa. For information write A C Beiler, c/o Westinghouse Electric Corp, 2-F Materials Engineering dept, East Pittsburgh, Pa.

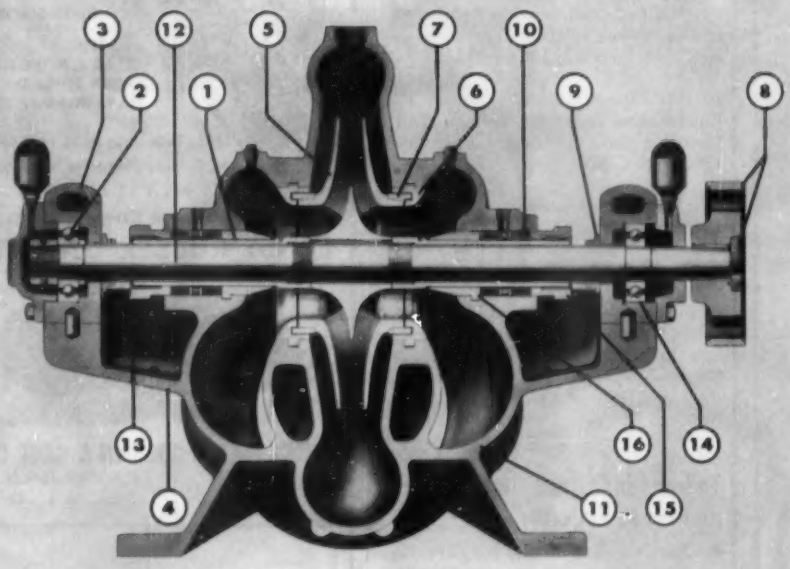
June 20-24—American Society for Engineering Education, 63rd annual meeting, Pennsylvania State University. Details from Prof K L Holderman, general chairman, 103 Mechanical Engineering Bldg, Pennsylvania State University, State College, Pennsylvania.

June 26-July 1—American Society for Testing Materials, 58th annual meeting. Chalfonte-Haddon Hall, Atlantic City, N. J. Full information from ASTM, 1916 Race St, Philadelphia 3, Pennsylvania.

June 27-29—American Nuclear Society, 1st annual meeting. Pennsylvania

DE LAVAL
SINGLE STAGE CENTRIFUGAL PUMPS

for dependable industrial service



Labyrinth wearing rings minimize leakage...maintain high efficiencies

Labyrinth rings used in these De Laval pumps retard flow of water through labyrinth passage.

Flat rings showing relatively unimpeded flow of water.

(1) **Shaft Sleeves** are screwed on, to abut the impeller and make a water-tight joint. Sleeve expands freely and independently of shaft when temperatures change. There is no tendency to buckle.

(2) **Thrust Bearing** locates rotor axially.

(3) **Bearing Caps** easily removable for maintenance.

(4) **Bearing Brackets** scraped to lining bars for perfect alignment.

(5) **Impeller** hydraulically balanced, finished on all surfaces.

(6) **Labyrinth Wearing Rings** held accurately in machined grooves in both case and cover.

(7) **Impeller Wearing Rings** threaded on impeller, opposite to rotation.

(8) **Flexible Coupling** ground on all exposed surfaces and statically balanced, complete coupling supplied, pump half mounted on taper so that it can be easily removed. Check nut locks coupling on taper.

(9) **Deflector** keeps water out of bearing.

(10) **Stuffing Boxes** extra deep; lantern rings for water sealing.

(11) **Pump Case** horizontally split; machined to limit gages.

(12) **Steel Shaft** ground to limit gages.

(13) **Drip Boxes** large; provided with drain openings.

(14) **Radial Bearing** free to move axially, thus avoiding temperature strains.

(15) **Glands** split horizontally.

(16) **Protecting Bushings** renewable.

You can count on the performance of the De Laval Single Stage Centrifugal Pumps because they are precision-made to high manufacturing standards and incorporate the many quality design features shown in the cross-section.

They operate at high or low speeds, at high or low heads...with maximum efficiency.

For example, De Laval G, I and K Single Stage Double Suction Pumps have a capacity range of 175 gpm to 6,000 gpm, and heads to 300 feet. They are available in sizes ranging from 4" suction and 3" discharge to 14" suction and 12" discharge. Write for Bulletin 1002.

DeLaval also furnishes larger centrifugals for capacities up to 70,000 gpm. Bulletin 83-29R sent on request.

DE LAVAL *Centrifugal Pumps*

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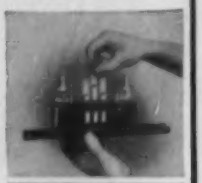

Just fill 3 test tubes with the sample to be tested and place them in the base...

add reagent to middle tube only...

place color standard slide on base. Move the slide across until the colors match and...

There's the Value!

You can make pH, chlorine, phosphate or nitrate determinations with these 3 easy steps with Taylor Comparators. Complete water analysis, including fluorides, is only a little more detailed when you use a Taylor Water Analyzer. Taylor sets are lightweight, durable, portable. Many different tests can be made on a single base. Best of all . . .

COLOR STANDARDS ARE GUARANTEED

Taylor liquid color standards carry an unlimited guarantee against fading, thus there's no chance of mechanical inaccuracy. Since a complete set of standards for any one determination is enclosed in a sturdy plastic slide, there's no need to handle fragile single standards.

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More POWER NEWS

Begins on page 158

State University. Complete information from Prof W W Miller, Pennsylvania State University, State College, Pennsylvania.

June 27—July 1—American Institute of Electrical Engineers, summer general meeting. New Ocean House, Swampscott, Mass. For details write AIEE, 33 W 39th St, New York 18, New York.

July 12-14—Second Western Plant Maintenance and Engineering Show, Pan Pacific Auditorium, Los Angeles, Calif. Details from WPMES, 759 Monadnock Bldg, San Francisco 5, California.

July 18-20—Sixth Diesel Power Plant Conference, Iowa State College. Full information from Engineering Extension, Iowa State College, Ames, Iowa.

Aug 15-19—American Institute of Electrical Engineers, Pacific general meeting. Butte, Montana. Details from AIEE, 33 W 39th St, New York 18, N. Y.

Aug 22-23—"Electronics and Automatic Production," national symposium. San Francisco, Calif. Information from National Industrial Conference Board, 247 Park Ave, New York, N. Y., or Stanford Research Institute, Palo Alto, Calif.

To build industry's first nuclear test reactor

► THE WORLD'S FIRST industry-owned nuclear materials test reactor will be built by Westinghouse Electric Corp, it was announced by Gwilym A Price, the firm's president. Cost of the project will be $6½-million.

This sum, Mr Price said, represents the largest commitment of private funds for an atomic power development facility ever made by American industry. The full-scale Westinghouse Test Reactor (WTR), to be used for testing materials under conditions of intensive nuclear radiation, will be the first element of a "reactor center" to be built by the company. Plans, pending approval of the Atomic Energy Commission, are to locate the reactor center on the company's 550-acre site near Blairsville, Pa., 40 miles east of Pittsburgh. The WTR will operate in the range of 10,000 kw.

"This reactor will help break through what we think is the number one bottleneck in America's progress in nuclear power by providing needed new facilities to test reactor fuel elements and other components of atomic power plants under actual operating conditions," Price declared.

"Up to now, organizations such as Westinghouse, working on the development of nuclear power plants, have had to depend on the limited radiation fa-

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FIG. 21—Lip Mold

FIG. 22—Standard

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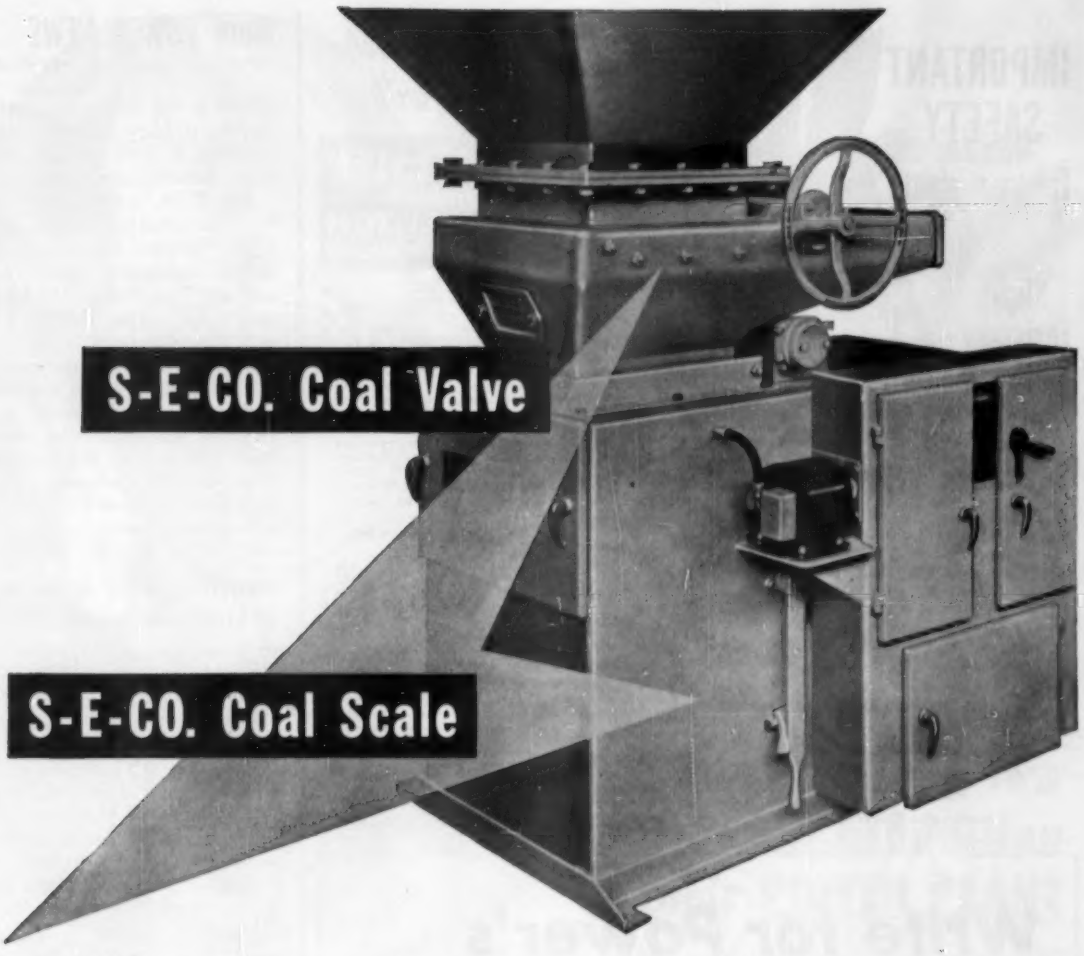

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Notice how the valve and scale fit together. The valve outlet forms part of dust-tight slip joint at scale inlet. The scale is designed to allow the valve dust cover to extend over it, not into the aisle where it is an accident hazard . . . and the whole arrangement is not only compact but built to last — and last.

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IMPORTANT SAFETY for your plant!

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- Safe, sane & sensible
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Range of 10 adjustable sizes fits all valve wheels from 2 to 30 inches diameter, with rising or non-rising stems. Only four simple, quickly-assembled parts.

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More POWER NEWS

Begins on page 158

cilities at the AEC's Materials Testing Reactor in Idaho and other government reactors as well as Canada's Chalk River Reactor," he continued.

The WTR, according to Price, will be of an advanced design and will use highly enriched uranium as the power source, and water as moderator and coolant. Uranium would be obtained under AEC license. Test holes into which materials may be placed to be irradiated will afford greater test capacity and flexibility than any reactor yet built in the United States. Large test thimbles will pierce the nuclear core itself and will be big enough to test large size fuel specimens. The reactor is expected to be in full operation within two years.

Radiation safety is theme of health conference

► A health physics conference, covering the field of radiation safety, will be held June 13-15 at Ohio State University. Topics on the program will include radioactive waste disposal, air sampling, dosimetry, health physics instrumentation, legislation, reactor safeguards, and other specialized subjects.

Details of the conference may be obtained from F J Bradley, Office of Radiation Safety, Ohio State University, Columbus 10, Ohio.

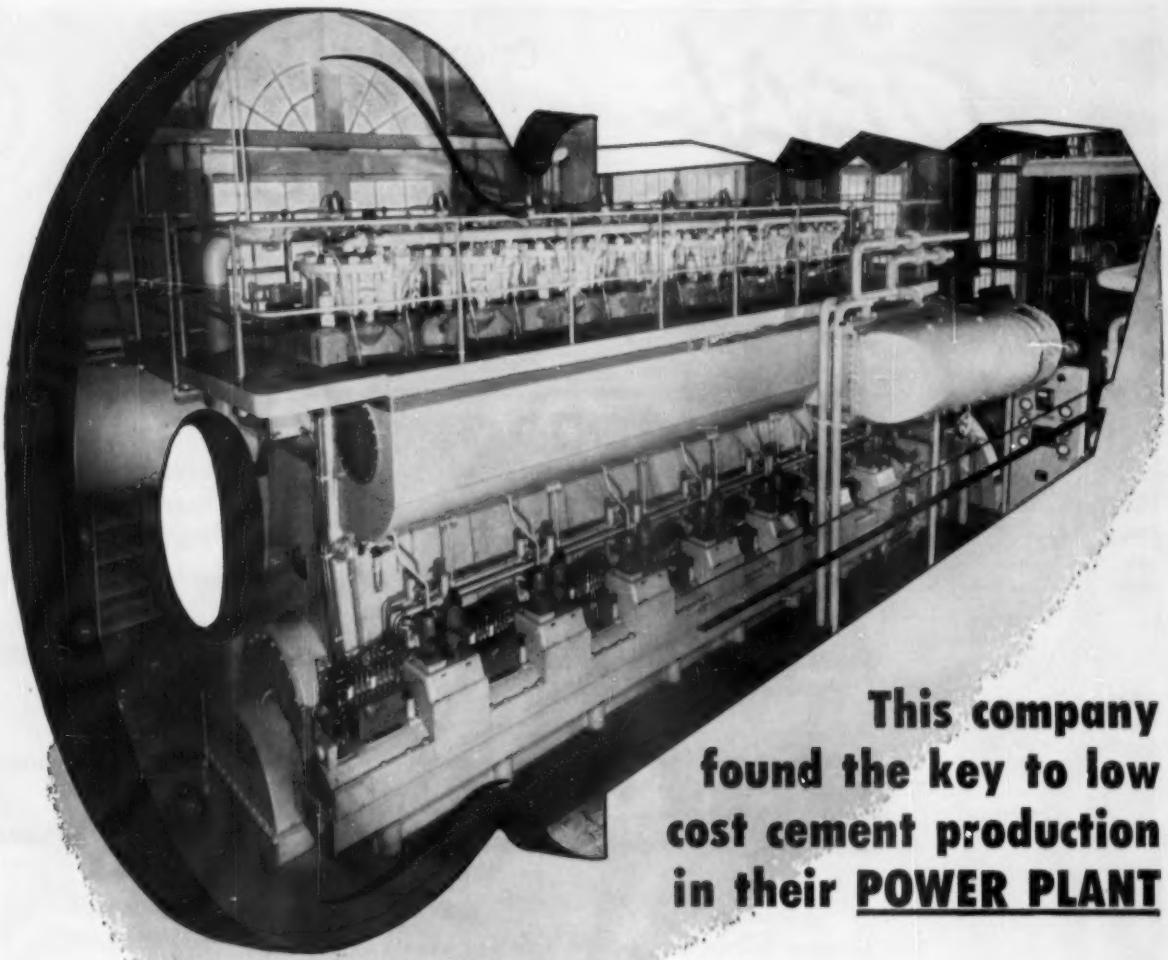
Plant inspection urged for local fire departments

► INDUSTRIAL PLANTS DEPEND on the village firemen or those from the nearest city for help, even though they have their own fire departments. This is the view expressed by Earl R Wallace, safety engineer of Eastman Kodak Co, speaking at the Greater New York Safety Council's annual convention.

He urged that village fire companies and fire department personnel from nearby cities should be taken on plant tours and be familiarized with operations and physical setup. Such measures would undoubtedly cut down on personal loss and property damage resulting from fire and other disasters.

"This is a very important point," Wallace stated, "because many times men are injured and property is lost because industry has not deemed it wise or necessary to take into their confidence those people whom they expect to give them assistance."

The city of East Palestine, Ohio has awarded a contract to Worthington Corp for a 5000-kw turbine generator to be installed in the city's municipal light plant.



This company found the key to low cost cement production in their POWER PLANT

● Knowing that low cost power means lower cost cement production, this progressive company has long depended upon Diesel generating units as the main source of processing power for their modern cement plant.

The first Nordberg engine, a 3600 hp, 2500 kw gas burning unit, was installed in this plant in 1948. In 1953, when additional capacity was required, another large Nordberg gas burning engine was installed—a 3010 hp, 2100 kw unit.

It is interesting to note that while this plant has a total of eight Diesel generating units, the two Nordberg engines represent over half of the total installed horsepower and carry 75% of the total load.

This is another example of the way Nordberg Engines are used for dependable, low cost industrial power. Next time you have a chemical-process power problem think of Nordberg . . . builders of America's largest line of heavy duty engines, from 10 to over 12,000 horsepower.

NORDBERG ENGINES FOR EVERY POWER NEED

For main or stand-by service, you can't beat the advantages of Nordberg Engines. They can be added to the line quickly, can be held ready for instant service without exorbitant stand-by expense, and are available for fully automatic operation. In the complete line of Nordberg two and four-cycle engines, including both oil and gas burning types, you will find exactly the right unit to meet your present and future power requirements . . . from 10 to over 12,000 horsepower.

NORDBERG

DIESEL • DUAFUEL® AND SPARK-IGNITION GAS ENGINES

NORDBERG MFG. CO.
Milwaukee, Wisconsin
Builder of America's Largest Line of Heavy Duty Engines

MAIL THIS COUPON TODAY

Nordberg Mfg. Co., Milwaukee, Wisconsin

Send information on Nordberg engines in the _____hp range for _____service.

Name _____

Company _____

Address _____

City _____ Zone _____ State _____

P1054

Real economy in condenser tubes is achieved when a sound balance is achieved between first cost, long-range operating efficiency and maintenance expense.

In applications where contaminated salt or fresh water and high velocities are encountered, Bridgeport Duronze IV (Alloy 53) Condenser Tubes meet these requirements. Although first cost is slightly more, the improved performance, better corrosion resistance and longer tube life, prove the ***Real*** economy of Bridgeport Duronze IV.

Bridgeport's Technical Service will be happy to tell you about the economies of Duronze IV, or recommend one of the many other Bridgeport Condenser Tube Alloys best suited for your particular application. Call your local Bridgeport office for immediate service.

Want to receive our monthly Copper Alloy Bulletin regularly? Ask us to add your name to our mailing list. The Bulletin contains news about the latest developments in the condenser tube field and useful design and maintenance helps.

BRIDGEPORT BRASS COMPANY • BRIDGEPORT, CONNECTICUT

Serving Industry with a Nationwide Network of Conveniently Located Sales Offices and Warehouses.

Mills at Bridgeport, Conn., Indianapolis, Ind., and Adrian, Mich.

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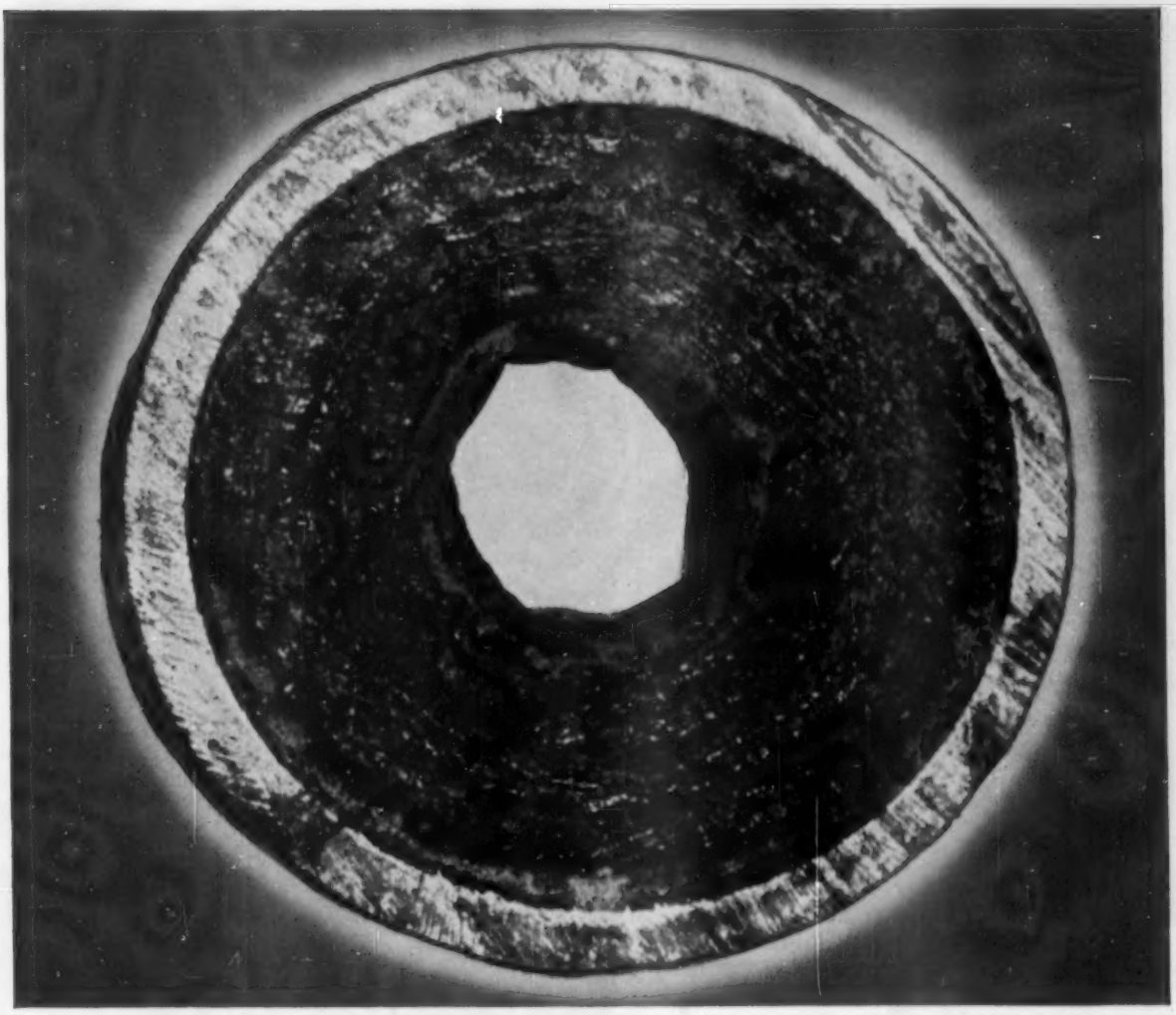


END OF THE LINE

SCALE—layer upon layer of it—has reduced the inside diameter of this pipe to practically nothing. It's a common occurrence in some power plants, and the results are costly. The line must be taken out of service. That means production loss and expensive maintenance or replacement.

Scale, sludge, carry-over, and return-line corrosion are but a few of the problems that must be overcome to assure efficiency in boiler plant operation. In Dearborn's complete line of water conditioning products, there is the correct treatment to eliminate every water trouble—the properly balanced treatment to reduce unnecessary maintenance, avoid shutdowns, and protect valuable equipment.

Since 1887, Dearborn products have provided trouble-free water to users of steam in all types of industry. That's why, today, power engineers in leading industrial plants throughout the nation look to Dearborn for consultation and assistance in solving their water treating problems.

Dearborn®

...a leader in water conditioning and corrosion control

MAIL THE COUPON

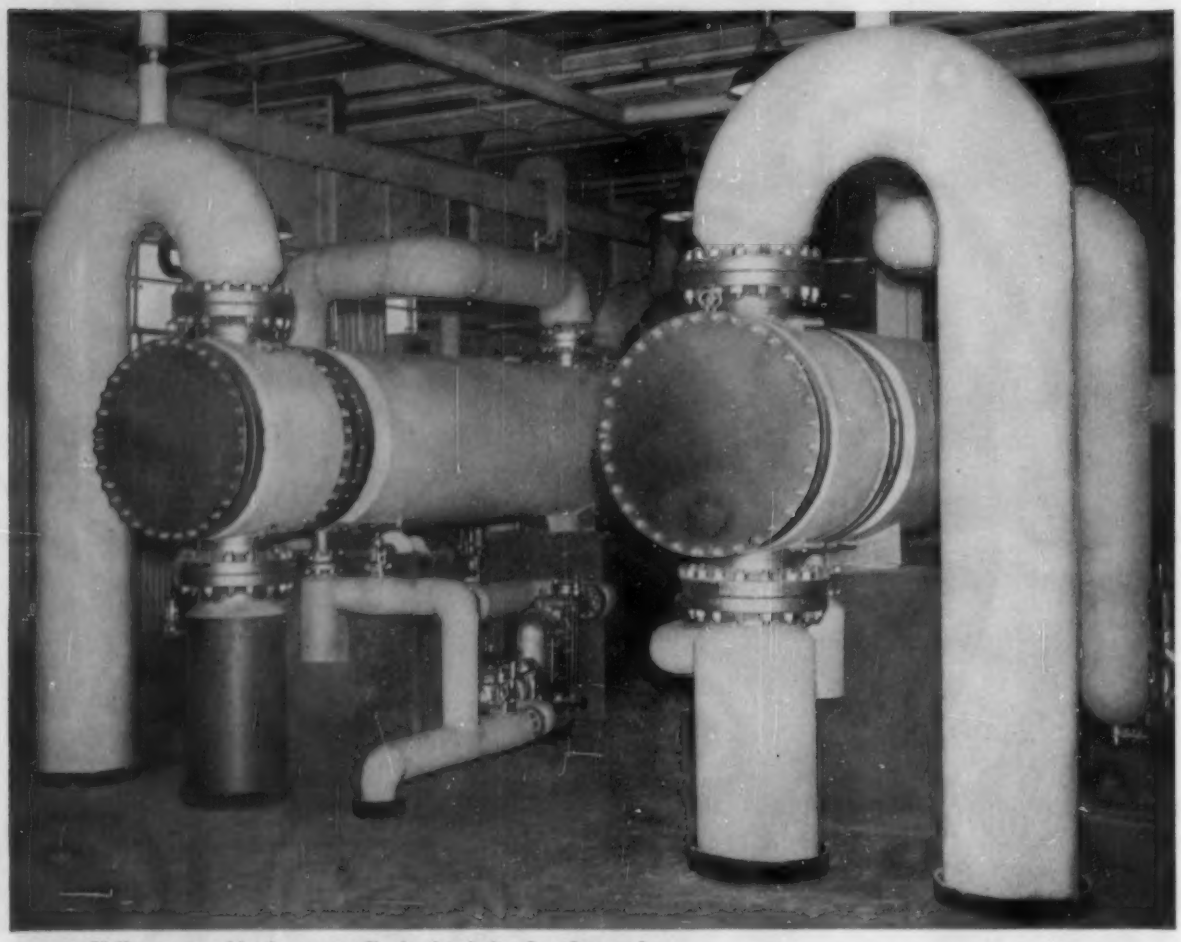
Dearborn Chemical Company, Dept. PO
Merchandise Mart Plaza, Chicago 54, Ill.
Please send me complete information on Dearborn Water Conditioning.

Name.....*Title*.....

Company.....

Address.....

City.....*Zone*....*State*.....



Unibestos provides low cost, effective insulation for pipes and exchangers used in the Great Northern chemi-groundwood plant.

Unibestos reduces application costs on bends and joints

Here is a stronger, longer lasting insulation that can be cut and mitered for quick, easy insulation of bends, expansion joints, tees, ells and other fittings. A minimum of cementing is required at the joints because UNIBESTOS' long, interlacing fibers form positive heat seals.

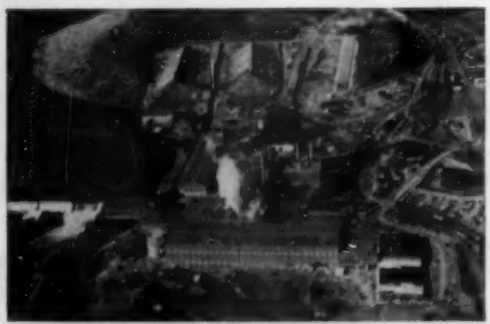
Unusually durable, Unibestos withstands vibration and impact... remains unaffected by acid and chemical fumes so often encountered in the paper industry... can be removed and reused as often as necessary.

Greater Efficiency with Unibestos®

Amosite, the well known South African asbestos with the long resilient fibers, gives Unibestos its superior insulating qualities. Heat loss at the joints is minimized due to interlacing of fibers.

Standard Production Sizes

Unibestos Pipe Insulation is regularly made in 3-foot lengths for pipe sizes from ½" through 24", in standard thicknesses through 5". Unibestos Block Insulation is made in 6", 12", 18" or 36" widths and in thicknesses from 1" through 3" in ½" increments.



In its multimillion dollar expansion program, the Great Northern Paper Company utilized Unibestos to provide efficient insulation for many processes.

For complete information, write for descriptive Bulletin 109C

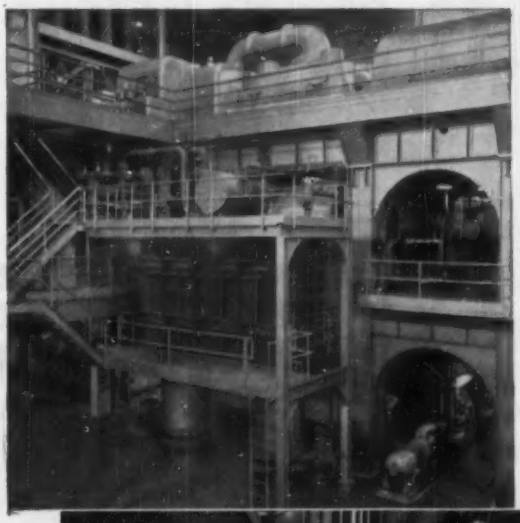
UNARCO

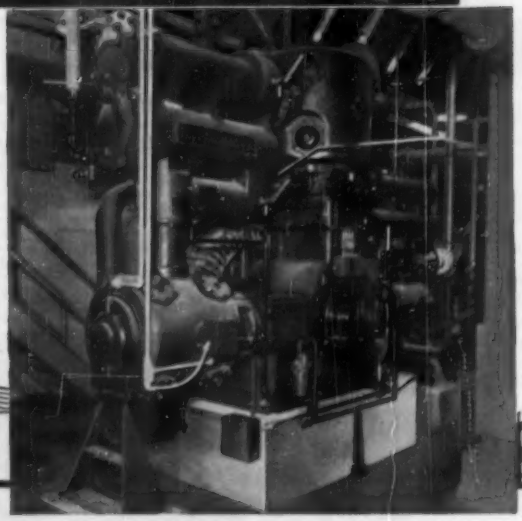
UNION ASBESTOS & RUBBER COMPANY

1111 West Perry Street • Bloomington, Illinois

PROVED DEPENDABILITY

in Power Plant Equipment





Condensers: Surface types for every generating capacity in space-saving rectangular design. Also Disc-Flow and ejector jet barometric condensers and a complete line of I-R auxiliaries, including steam-jet ejectors, vacuum pumps, air leakage meters, circulating and condensate pumps.

•

Boiler Feed Pumps: For all pressures, capacities, and temperatures. Also single and multi-stage pumps for every power plant requirement in centrifugal, mixed and axial flow types.

•

Compressors: Stationary air compressors are available in all sizes and types, either direct connected or belt driven, for soot blowing, instrument air and other power plant services. A complete line of Gyro-Flo portable air compressors in sizes to 600 cfm provide a dependable source of air power for plant construction and maintenance.

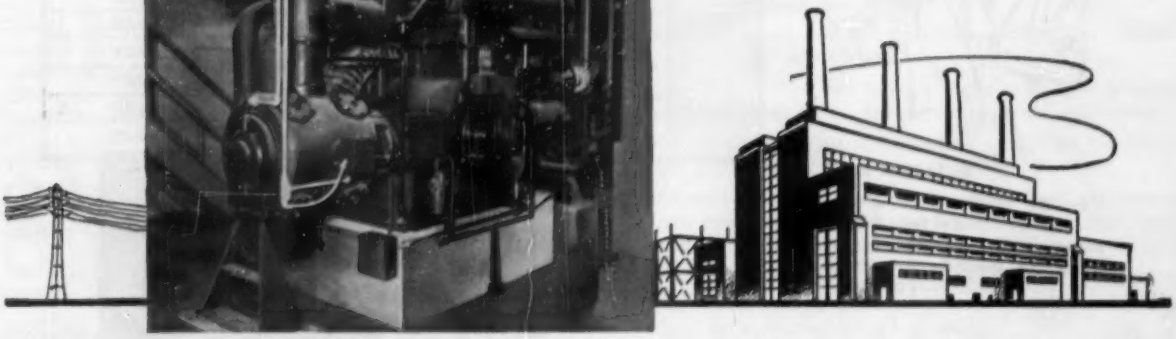
•

Ingersoll-Rand's specialized experience in building dependable power plant equipment is at your service. A call or letter to your nearest Ingersoll-Rand office will bring a quick solution to your specific problems. There's no obligation, of course.

Ingersoll-Rand

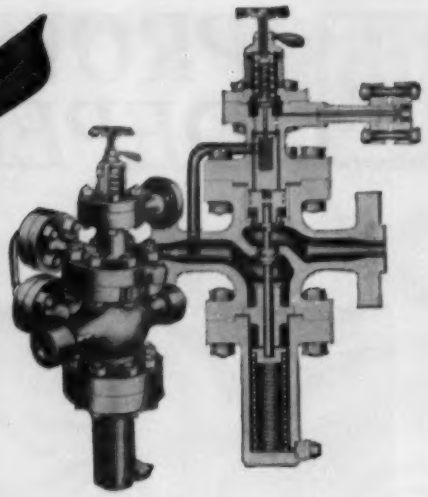
11 Broadway, New York 4, N. Y.

14-33



AIR AND ELECTRIC TOOLS • DIESEL ENGINES • PUMPS • CONDENSERS • COMPRESSORS • VACUUM EQUIPMENT

the PRESSURE'S ON!



STEADILY, CRITICALLY, AUTOMATICALLY, with **LESLIE**

PRESSURE REDUCING VALVES

Now you can handle high pressure drops without costly, complicated two-stage reducing stations. Handling up to 1500 psi 1000° F inlet steam, the single-seated, internal pilot, piston operated valve has *proven* itself in high pressure central station service, as well as in lower pressure industrial service. High pressure applications include steam to auxiliaries, air jets and steam soot blowers. List of central station users available on request.

Engineers have put their reliance on Leslie for the best in design, materials and workmanship—in all kinds of industrial applications—for more than 55 years.

Send for the bulletin described below today.

- **For Steam, Air, Gas**
- **99% Accuracy of Regulation**
- **Instant Reaction to Flow Change**
- **Stellited Seating Surface**
- **Positive Dead-End Shut-Off**
- **Interchangeable Parts**

BULLETIN 3302

Provides latest engineering data on all classes of Leslie Pressure Reducing Valves—assists you in planning and specifying for optimum performance. Yours on request.

TYPICAL PRESSURE RANGES

CLASS	BODY MATERIAL	SIZES	INLET STEAM PRESSURES	REDUCED PRESSURE RANGE
LLK	Cast Iron	½"-6"	25-250	2-35
LK	Cast Iron	½"-6"	25-250	10-235
LL-3	Cast Bronze	½"-4"	25-300	2-35
L-3	Cast Bronze	½"-4"	25-300	10-285
LL-4	Cast Bronze	5"-6"	40-300	5-35
L-4	Cast Bronze	5"-6"	40-300	20-275
HS-2	Cast Carbon Steel & Cast Alloy Steels	½"-3"	300-750	100-600
HS-3		1"-3"	300-1500	100-600

TRADE LESLIE MARK

LESLIE CO., 235 Grant Avenue, Lyndhurst, New Jersey

Hudson saves $480,000 a year burning coal the modern way

A decision to improve its power service opened many possible courses of action to Hudson Motor Division of American Motors Corp. Based on findings of consultants Boddy, Benjamin and Woodhouse, Inc., Hudson decided to modernize completely its coal-burning, steam, electrical and compressed air equipment.

Today, steam at Hudson is supplied by three new boilers instead of ten old ones. Other new equipment includes a coal-handling system, automatic combustion controls and automatic ash disposal system. Manpower needs in the boiler area have been cut from 14 to 10 and in the compressor area from 8 to 6. With a reliable power supply, Hudson is protected from service interruptions. And the reduced cost of operation resulting from the new equipment will pay off the original investment in six years, leaving an annual saving of $480,000 thereafter!

Investigate Your Fuel Costs

If you're planning to modernize your plant or build a new one—or if you are just interested in cutting fuel costs—find out how coal, burned the modern way, compares to other fuels. Why not talk to a consulting engineer or your nearest coal distributor. Their advice may save you thousands of dollars each year.

facts you should know about coal

Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar.

Automatic coal and ash handling systems can result in a virtually labor-free plant.

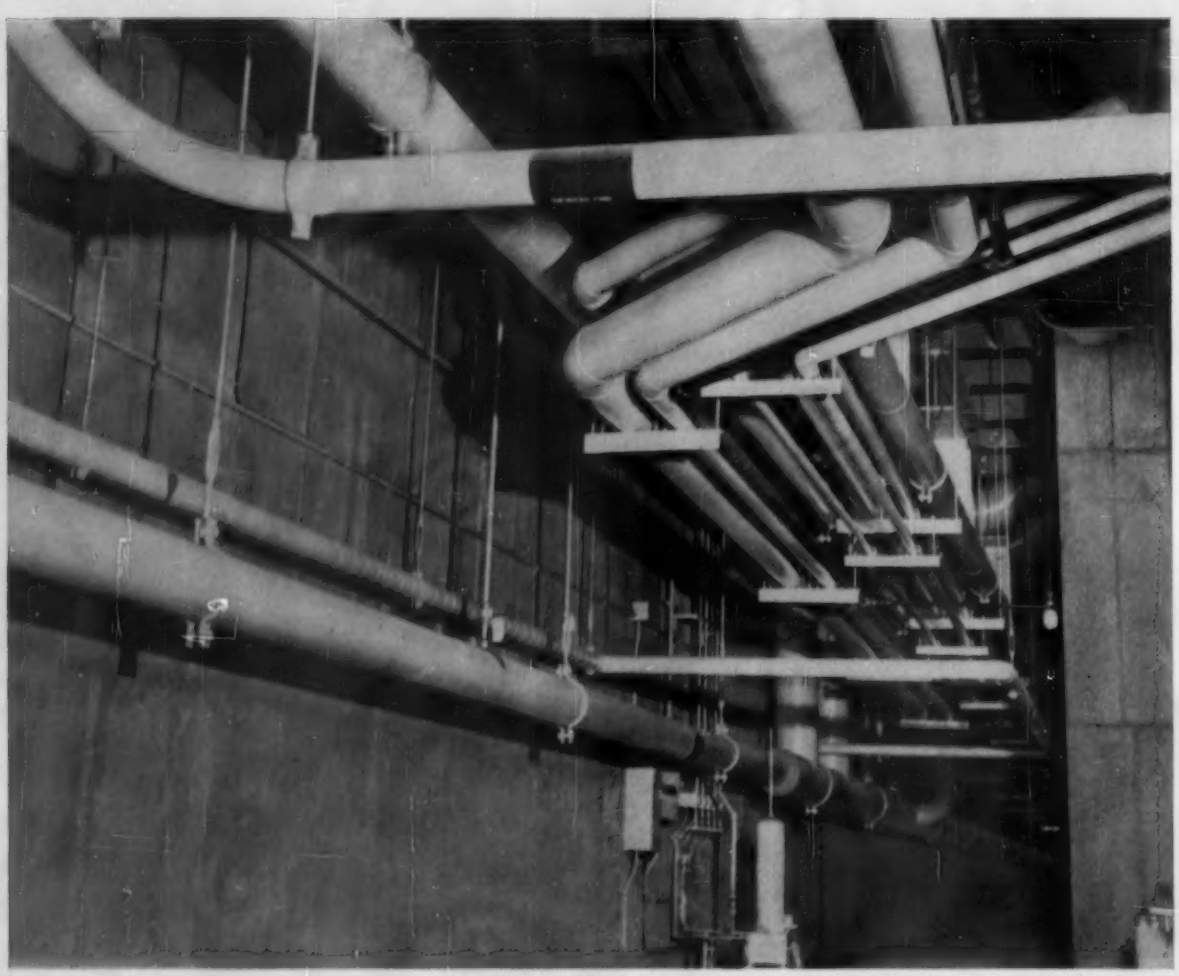
Coal is the safest fuel to store and use. No dust or smoke problems when coal is burned with modern equipment.

In most industrial areas, bituminous coal is the lowest-cost fuel available.

Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

NATIONAL COAL ASSOCIATION
Southern Building, Washington 5, D.C.



Steel mill piping in descaling basement of Fairless Works' 80 inch hot strip mill

IN U. S. STEEL'S FAIRLESS WORKS . . .

14½ miles of BLAW-KNOX piping serve two important mills

In the huge Fairless Works of the U. S. Steel Corporation are 78,000 feet of Blaw-Knox piping . . . in sizes ranging from ¼ inch to 24 inches.

At temperatures and pressures required for specific services, this piping system carries air, steam, water, gas, oxygen and oils to the 80 inch hot strip mill, the 45 inch slab mill and associated mill equipment.

Fabrication and erection of the system were started by the Blaw-Knox Power Piping Division a year and a half before scheduled completion date. For each phase of the work had to be synchronized with the over-all building program, in order to have the mills go into production on time. Prime contractor was Patterson-Emerson-Comstock, Inc.

The same experience, skill and facilities of our Power Piping Division, which successfully handled this job, are always available to you. Just let us know your requirements and we'll provide the service you need.

To get more information on piping for industry, send for your copy of Bulletin No. 2443.

BLAW-KNOX COMPANY

Power Piping and Sprinkler Division

Pittsburgh 33, Pennsylvania

POWER PIPING

Complete prefabricated piping systems for all pressures and temperatures . . . plus complete line of functional spring hangers • constant support spring hangers • rigid hanger assemblies • overhead roller assemblies • supports • vibration eliminators

THIS IS THE INTERRUPTER...

BROWN BOVERI

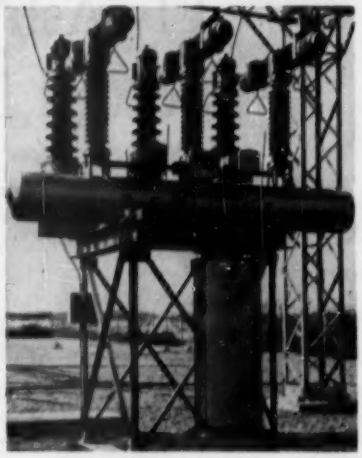
AIR BLAST BREAKERS

GOOD circuit breaker design calls for getting the interrupting medium between the contacts as FAST and as EFFICIENTLY as possible.

In practice, the best way is to use a low inertia medium — such as *air* in contrast to *oil* — controlled by a few, light, moving parts. **The interrupter (shown above) with its small, precision parts, releases the arc-quenching blast of air almost instantly.** Note the absence of heavy, moving parts in this important assembly.

This, and similar engineering achievements, make possible all these advantages which only a Brown Boveri Air Blast Breaker can provide:

1 – High Interrupting Capacity
2 – High Current Carrying Capacity
3 – High Speed
4 – Rapid Reclosing
5 – Positive Interruption under All Conditions
6 – Proven Dependability
7 – Low Initial Cost
8 – Low Installation Cost
9 – Minimum Maintenance
10 – Rapid and Easy Inspection



69 kV Brown Boveri Air Blast Breaker in Cochise Substation, Bureau of Reclamation, Phoenix, Ariz.

You can EXPECT MORE . . . and GET MORE from a Brown Boveri Outdoor or Indoor Air Blast Breaker. **Get the facts TODAY!**

BROWN BOVERI

BROWN BOVERI CORPORATION

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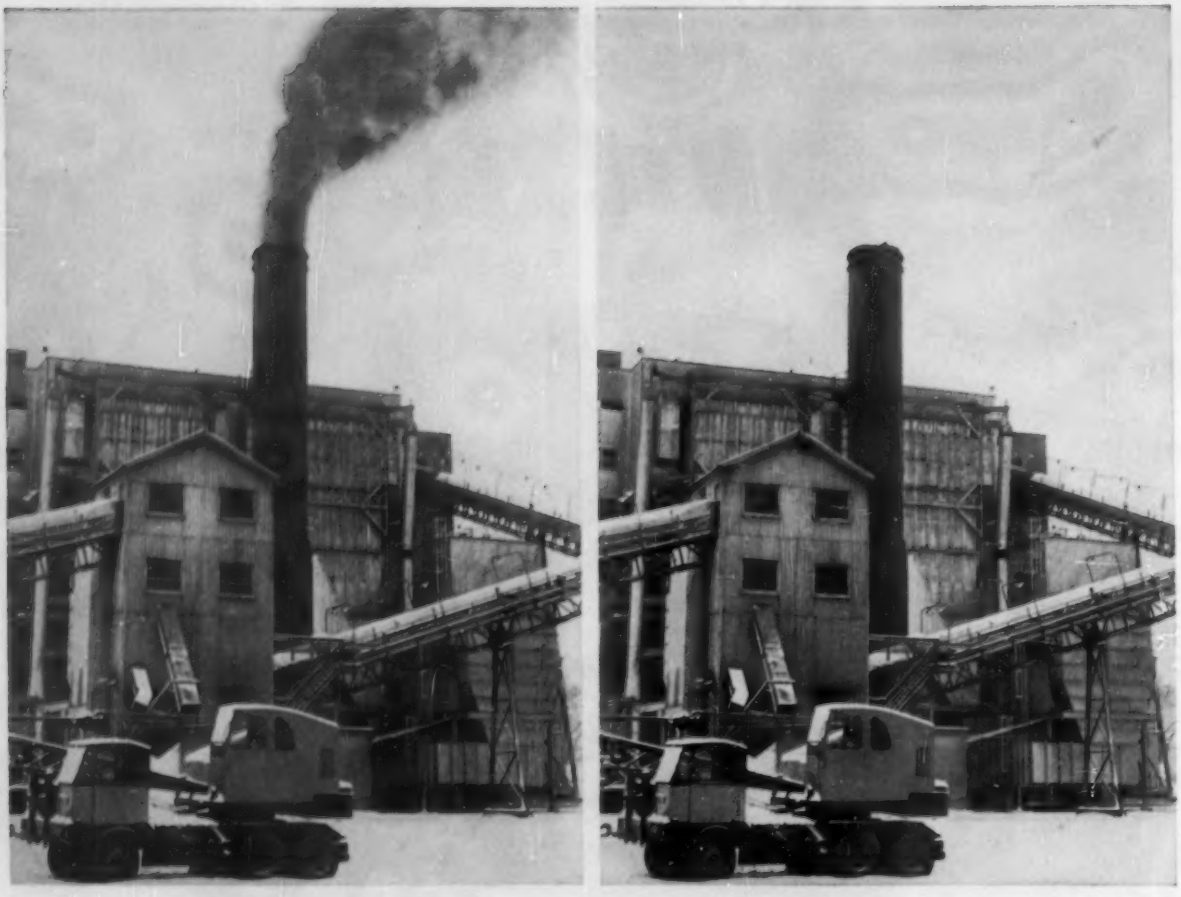

Fly Ash Problem Solved By Central Station

This Pennsylvania utility felt that as long as you can *see* dirty stack discharge, you have a problem. To solve it, they decided to insist on fly ash collection equipment with very high efficiency.

The electrical precipitators they chose, which were placed after existing mechanical collectors, are Cottrells, designed and built by Research-Cottrell. Their effectiveness is demonstrated in the above unretouched photographs. At the left, the precipitators were turned off long enough to take the picture showing the volume of fly ash discharged by the boilers. At the right, the precipitators are turned back on. Stack discharge is visually clean.

This is another example of industry's trend toward establishing its own higher standards for nuisance abatement. Research-Cottrell, which has made more fly ash installations than any other company, cites the following comparison:

In the period from 1923 to 1939 only 11% of its power plant customers specified fly ash collection efficiency of 95 to 98%. In recent years, that 11% has risen to fully 90%.

One reason, of course, is the generally increasing emphasis on community relations. Another factor is that far-sighted companies are anticipating stricter smoke regulations. They are anxious to install equipment that will end their smoke problems now and also prevent such problems from occurring in the future.

Still another factor is this. In recent years, with modern coal pulverization and advanced boiler design, there has been an increase in the fineness of fly ash particles. This calls for the most efficient equipment available.

Read—in Bulletins FA and MI—about Cottrell equipment and the Research-Cottrell's MI Rapper. This device eliminates rapping puffs and enables the precipitator to maintain, continuously, its high collection efficiency. Write for your copies today.

RC-183

RESEARCH-COTTRELL, INC.

A WHOLLY OWNED SUBSIDIARY OF RESEARCH CORPORATION

Main Office and Plant: Bound Brook, N. J.
405 Lexington Ave., New York 17, N. Y. • Grant Building, Pittsburgh 19, Pa.
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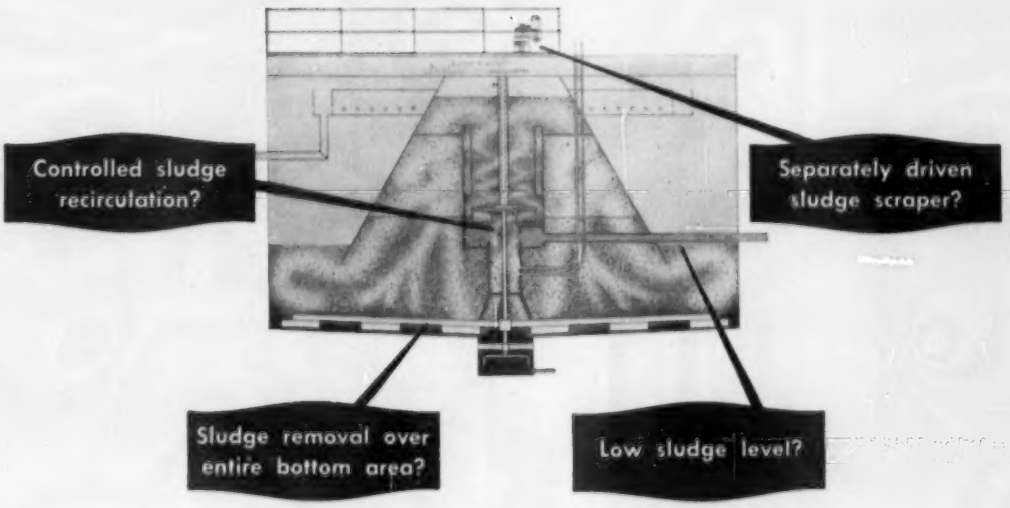
WHICH FEATURES...

ASSURE THE CLEAREST WATER?


Controlled sludge recirculation?
Separately driven sludge scraper?
Sludge removal over entire bottom area?
Low sludge level?

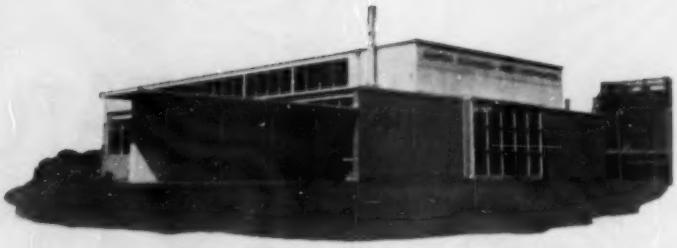
They <u>all</u> help to produce clear water. But only when all four features are combined in a single unit can you be sure of a dependable and economical supply of clear water at all times. The GRAVER REACTIVATOR®, a cold process softener and clarifier, is designed to combine <u>all</u> these features. Forty-five years of water conditioning experience have gone into this design — a design that has a proven, successful performance record in hundreds of installations.

WRITE FOR DESCRIPTIVE CATALOGUE WC-103A

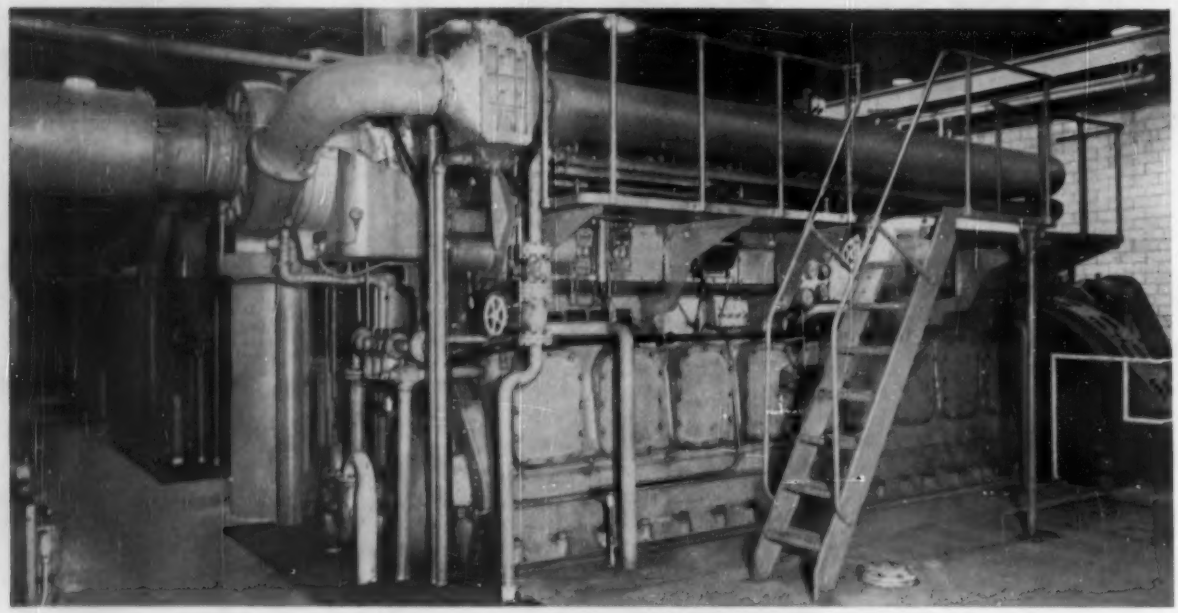
GRAVER

GRAVER WATER CONDITIONING CO.
A Division of Graver Tank & Mfg. Co., Inc.
216 West 14th Street, New York 11, N. Y.

The Agra Lite Cooperative near Benson, Minnesota houses five turbocharged Cooper-Bessemer Diesels, each rated 1850 hp at 327 rpm.



This view of Cooper-Bessemer Diesels at Benson shows after-coolers and exhaust-driven turbochargers. All five engines successfully use a No. 6 residual fuel oil.



How an "OIL CHANGE" saved $30,000 . . . in fueling Cooper-Bessemers

The ability of Cooper-Bessemer Diesels to run smoothly and effectively on either heavy fuel, light crude, or a combination of both, is but one of many reasons why so many Cooper-Bessemer units are being installed in cost-conscious plants throughout the country.

Here's an example . . . switching five 1850 hp Cooper-Bessemer Diesels from a higher priced lighter engine fuel to No. 6 residual fuel oil, the Agra Lite R.E.A. Cooperative near Benson, Minnesota effected a one year net saving of $29,769 . . . a remarkable 30% cost reduction.

And important to note is the fact that this "oil change" resulted in *no* increased wear on the smooth-operating turbocharged Cooper-Bessemers. In fact, the cleaning of valves, fuel pumps and nozzles periodically has shown these parts to be just as efficient, just as clean as when much lighter fuel was used.

Next time, why not check with Cooper-Bessemer for the ideal solution to *your* particular power problems.

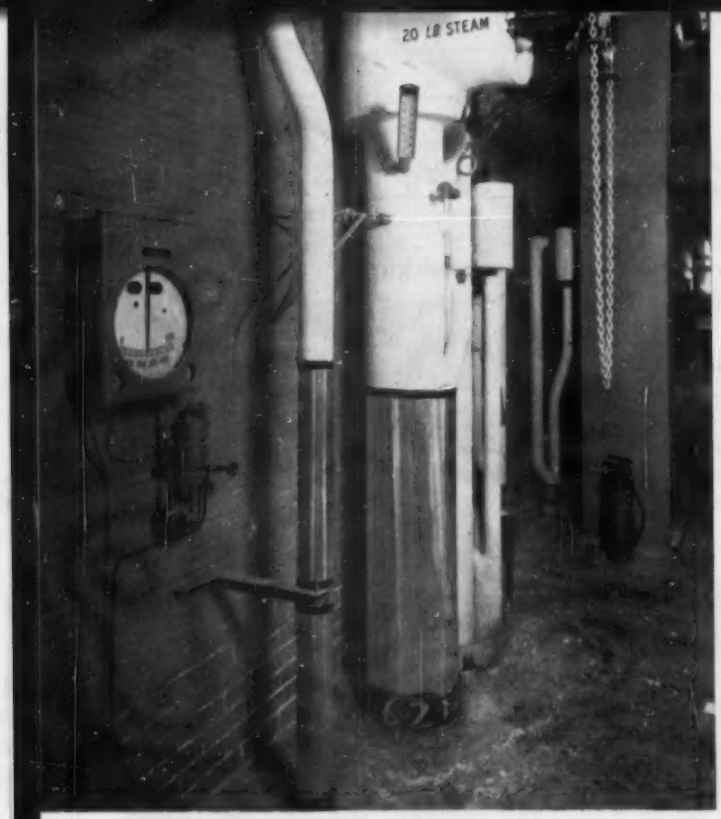
MOUNT VERNON, OHIO

COOPER-BESSEMER

GROVE CITY, PENNA.

New York City • Seattle, Wash. • Bradford, Pa. • Chicago, Ill. Houston, Dallas, Greggton, Pampa and Odessa, Texas Washington, D. C. • Shreveport, La. • San Francisco, Los Angeles, Calif. • St. Louis, Mo. • Gloucester, Mass. • New Orleans, La. • Tulsa, Okla. • Cooper-Bessemer of Canada Ltd., Edmonton, Alberta—Halifax, Nova Scotia.

DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS



PROBLEM: High maintenance cost of canvas jacketing. High-pressure hot water hose used to clean floor damaged lower ends of lines and necessitated constant replacement.

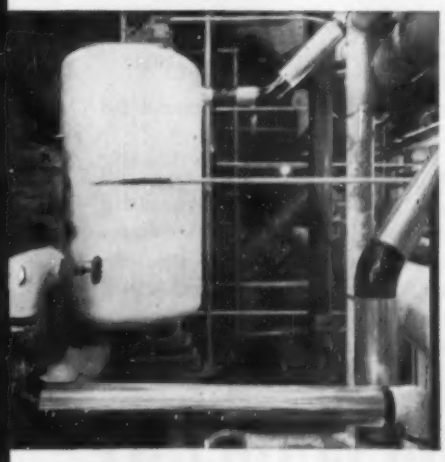
SOLUTION: Childers Aluminum Jacketing replaced canvas. Waterproof—easy to install—reusable.

PROBLEM: Extreme hazard of fire from static electricity generated in machinery. Canvas jacketing could burn easily causing danger to men and machinery in plant.

SOLUTION: Childers Aluminum Jacketing installed. Fireproof—easily cleaned of oil to reduce fire hazard.

Do Insulated Lines in Your Plant Cause These Three Common Problems and Hazards?

Read How Special Aluminum Jacketing Solved Them for Scott Paper Company



PROBLEM: Costly replacement of insulated lines damaged by oil drippage and bumping by men and tools.

SOLUTION: Maintenance engineers replaced canvas jacketing with Childers Aluminum Jacketing. Easy to wipe clean . . . durable and resistant to abrasion and abuse. Maintenance cost reduced.

The Scott Paper Company, Chester, Pa., and nearly 1,000 other modern plants in this country have protected insulated lines with Childers Aluminum Jacketing.

Childers Aluminum Jacketing cuts maintenance costs. It needs no upkeep . . . retains its protective value for years. Because Childers Aluminum Jacketing needs no painting, it can actually pay for itself in this saving alone. And of course, this modern aluminum jacketing can be removed and replaced easily for line repairs.

Easy installation cuts cost even farther. Only tools needed are pliers and wedge. Economical strapping holds jacketing securely—allows easy removal.

Try this low-cost protection in your plant. Write today for engineering data and information about how you can order a 400 sq. ft. roll to test on one of your insulated lines. No obligation. For full details write to: Childers Manufacturing Company, Department PO-11, 3620 West 11th Street, Houston 8, Texas.

SPECIFICATIONS

Childers Light-Weight Aluminum Jacketing

Shipped in rolls. 4 ft. wide; 100 ft. long with or without moisture barrier. Aluminum of .006" thickness. Cut with straight edge and dull knife. Write now for full details and engineering data.

LOW COST Childers Aluminum Jacketing answers many problems in plants all over the country. It's light weight, easy to install—goes on with simple bands. Weather, water, heat and fire resistant—can be used and re-used for years.

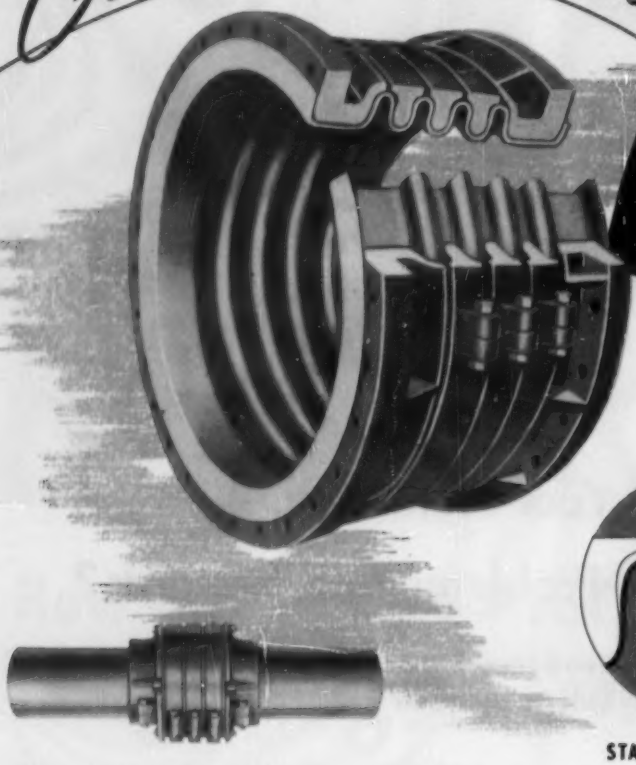
(Advertisement)

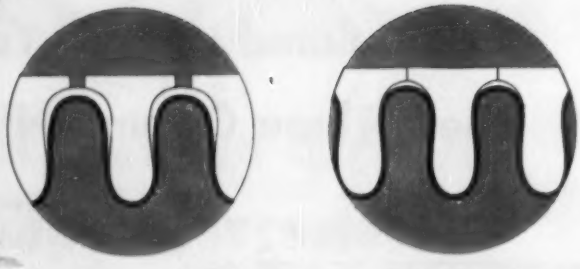
BADGER *Expansion Joints*

Typifying Expansion Joint Engineering At its Best

Controlled Movements

through **DIRECTED FLEXING**





STARTING POSITION (LINE COLD)

FINAL POSITION (FULL TEMPERATURE)

WITH THE OLD STYLE corrugations, there was little control over the flexing movement. Our engineers long ago found this to be a major cause of uncertain joint life and set about to solve the problem.

Directed Flexing, based on a scientifically engineered design of all-curve corrugation, solved the problem. That was some years ago. Notwithstanding continual further studies, nothing anywhere has supplanted Directed Flexing as a major design factor in long joint life. It's another example of what engineering has done to make the Badger Expansion Joint 'tops' in its field.

Badger Expansion Joints come in a variety of types and a wide range of sizes: Directed Flexing, Self-Equalizing for normal and long traverses and higher pressures; Non-Equalizing, for short traverse or when pressures are low; Tandem Joints for combination axial and lateral movements; Clevis-Hinged Joints for angular movements; Flexible Pipe Line Seals for watertight connections between pipes and flood walls.

BADGER MANUFACTURING COMPANY

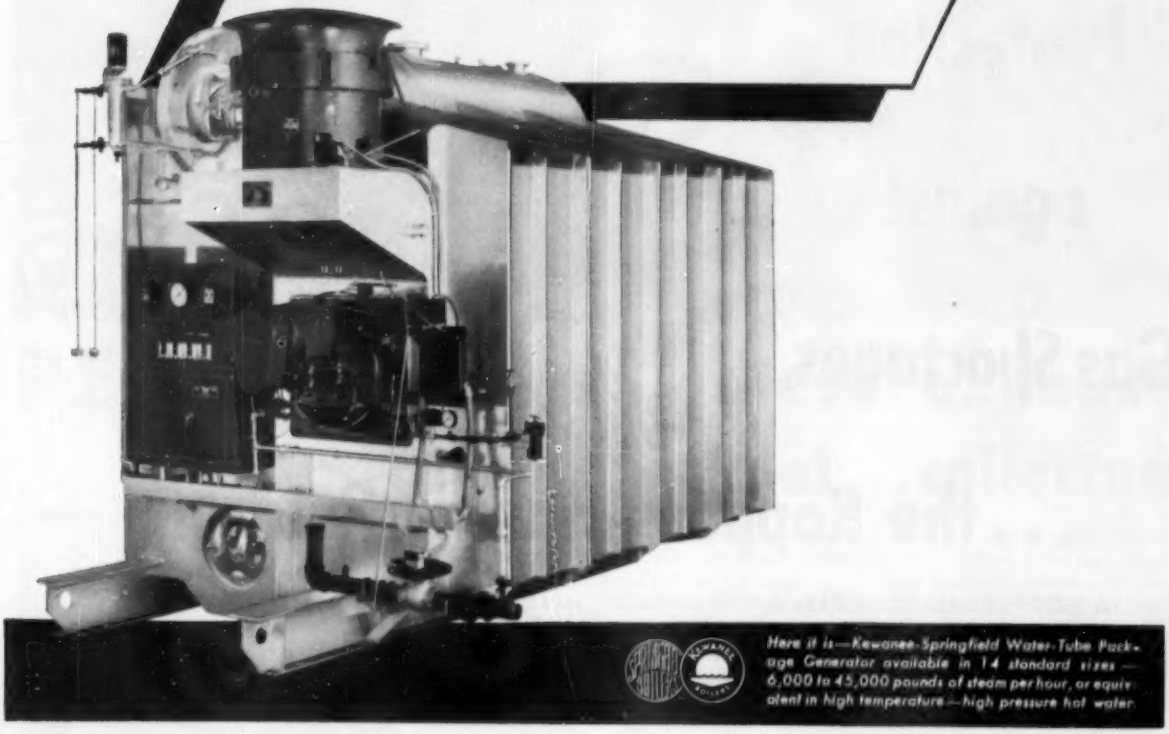
Original and Sole Manufacturer of Badger Expansion Joints

230 BENT STREET • CAMBRIDGE • MASS.

Announcing one of the most significant additions to our product line . . .

KEWANEE - SPRINGFIELD

water-tube package generator



Here it is—Kewanee-Springfield Water-Tube Package Generator available in 14 standard sizes — 6,000 to 45,000 pounds of steam per hour, or equivalent in high temperature—high pressure hot water.

Now from one source Kewanee offers you the broadest selection of boilers in the U.S.A.

When a new member is added to the family of products at Kewanee you may be sure much thought preceded such a move . . . thought of how you could better be served.

So with years of research and practical field experience behind us, we present the Kewanee-Springfield Water-Tube Package Generator. Manufactured by the Springfield Boiler Company and marketed coast-to-coast by Kewanee, it means from 1 source Kewanee now brings you the broadest selection of boilers in the U.S.A.

The Kewanee-Springfield Water-Tube Package Generator is the most compact power plant type unit. Specially selected, durable materials plus 2 drum bent tube design makes for maximum use of boiler space to deliver the greatest steam output. Steel encased—a complete unit with no extras required. Exclusive "6 wall" cooling permits high heat release rates.

All this adds up to lower operating cost . . . less fuel is required to deliver heat due to smaller heating surface with higher heat absorption. Maintenance cost is lower, too . . . double panel casing construction makes tubes easily accessible. Guaranteed maximum continuous capacity . . . can operate at peak loads without interruption.

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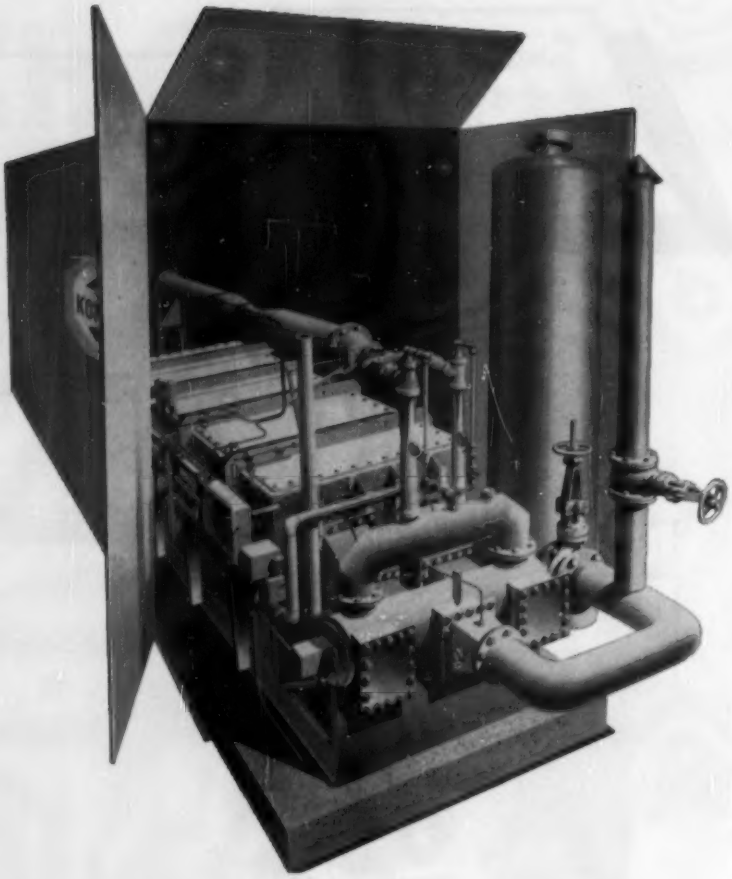

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A KOPPERS-HASCHE REFORMER produces low-cost gas that is interchangeable with most natural or manufactured gases. It is, therefore, ideal insurance against gas-supply emergencies.

If there is any interruption in the supply of natural gas, a Koppers-Hasche Reformer can "carry on" until normal service is resumed. This stand-by service is valuable to industries that utilize natural gas, because it prevents costly interruptions in the manufacturing processes.

The Koppers-Hasche Reformer is available in standardized "package" units. Through standardization of design, prefabrication of parts, and shop assembly, the Kopper-Hasche Reformer can be installed in your plant at remarkably low cost.

Operating cost is low, too. Units are almost entirely automatic in operation, requiring a minimum of operating labor and supervision. There are few moving parts, thus reducing maintenance.

For full details . . . send for this booklet describing the Reformer, its operation and its adaptability. Just write to:

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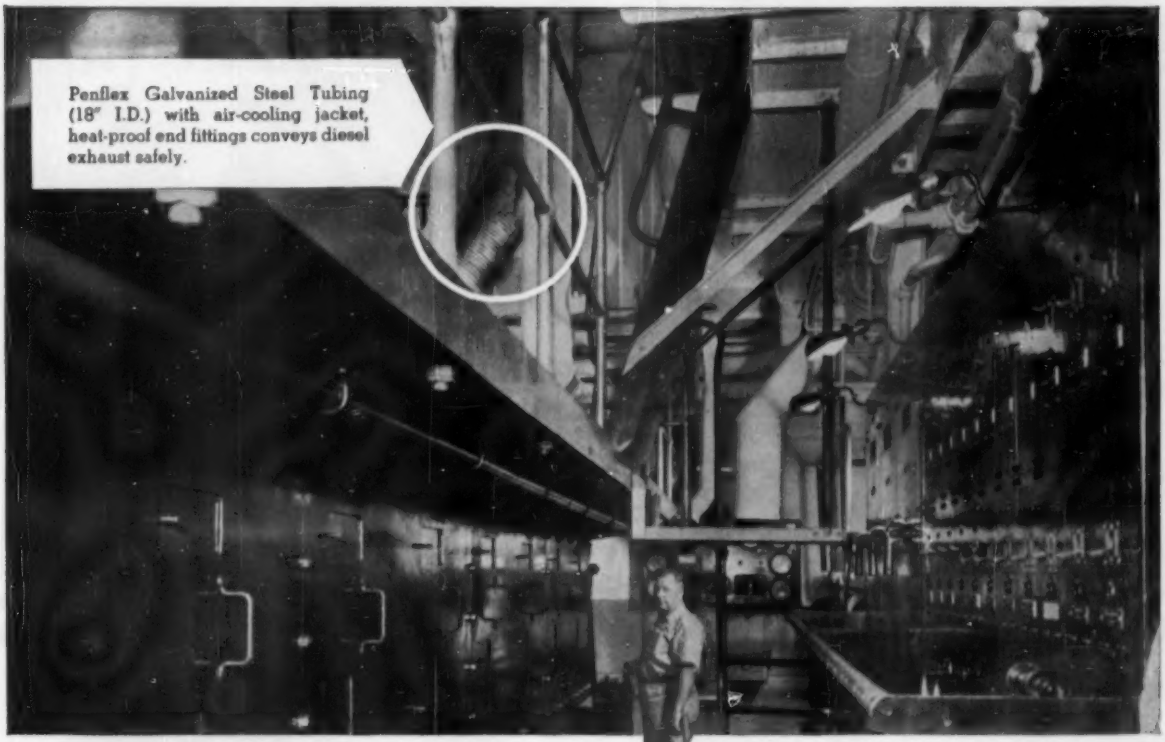
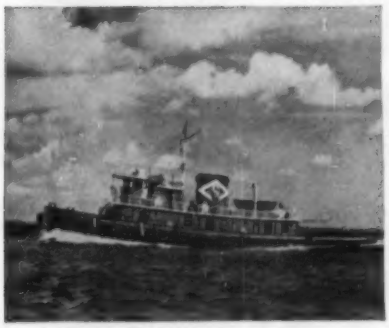


PENFLEX keeps diesel exhaust calm... cool...collected



Sea-towing tug powered by 8-cylinder supercharged diesel poses big job for Penflex Diesel Exhaust Tubing. Penflex rides ocean waves and shock waves to cushion vibration on 1750 hp. diesel exhaust.

One of the most powerful ocean-going tugs in the United States entrusts its exhaust problem to Penflex Air-cooled Flexible Steel Tubing. Penflex gives triple service. Its easy flexing "soaks up" tremendous vibration. Its outer jacket provides air cooling. Its four-wall interlocked construction keeps gases tight as a pipe from exhaust to stack.

This is only one of many marine applications. Penflex Interlocked Tubing and Penflexweld High-pressure Tubing also serve on air intakes, fuel oil and starting air lines, lubricating oil and circulating water lines in diesel application, and in hundreds of other ways. Wherever you convey air, gases, oils, steam, volatiles, or light solids by gravity or pressure . . . consider Penflex.

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Throughout this modern building, containing 190,000 square feet of floor space, air handling is by Clarage equipment.

Clarage products shown on the right and below are representative of those selected for Metropolitan Edison's new office and service headquarters.

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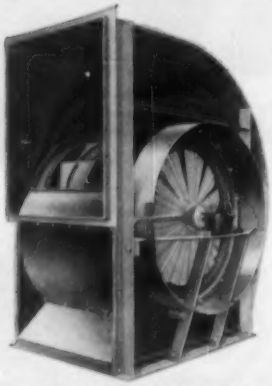
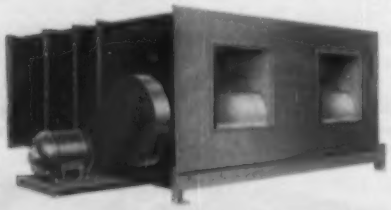
Recognizing this, the nation's leading engineers, architects, contractors, and building operators are demonstrating a growing preference for Clarage. Call us in for capable assistance on your next requirements. **CLARAGE FAN COMPANY, Kalamazoo, Mich.**



Clarage Type NH fans for ventilating, air conditioning, and various industrial process services.



Clarage Multitherm Units for comfort and process air conditioning applications.

Clarage Unicoil Units—sprayed coil equipment for central station air conditioning systems.

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Why Arizona Public Service chose Triple-Zone Gilsulate to protect 1200-foot fuel and steam lines

Sought lifetime protection against heat loss and corrosion

For its new Saguaro steam electric station near Red Rock, Arizona, the Arizona Public Service Company investigated several types of hot underground pipe insulation. The pipe system consists of three seamless carbon steel hot fuel and steam lines, totalling 1,200 feet, with welded joints running side by side between a 55,000-bbl. fuel oil storage tank and two 950,000 pound/hour steam generators.

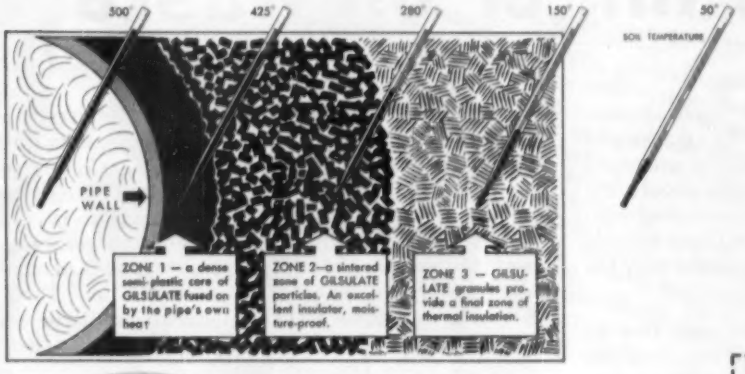
Arizona Public Service Company found that GILSULATE gave the quickest, simplest and most economical system of insulation for its underground hot fuel and steam lines. Approximately 40 tons of GILSULATE were poured and tamped by 10 laborers in two 8-hour shifts—far less time and less expense than required for the other types of insulation investigated.

This is the experience of hundreds of other installations—*Triple-Zone GILSULATE shows the lowest cost per installed linear foot of any hot underground pipe insulation!*

Facts about Gilsulate

1. *Easy to use*—just pour, tamp and backfill...pipe heat does the rest.
2. *Forms 3 zones of protection* against heat loss and all commonly encountered hazards to hot buried pipes.
3. *Needs no sleeves* or mechanical sheaths: no mixing or special handling.
4. *Needs only* normal pipe spacing: for multiple pipe or cramped conditions.
5. *3 types* for varying temperature ranges up to 520° F.

Lines include five horizontal expansion U-bends. A 6-in. fuel oil supply line, a 4-in. fuel oil return, and a 4-in. saturated steam line leading to the fuel oil tank heater were placed side by side in a 37-in. wide trench, and covered with GILSULATE. After light tamping of GILSULATE, trench was backfilled—and the work was done.


500°
425°
280°
150°
50°
SOIL TEMPERATURE
PIPE WALL
ZONE 1 — a dense semi-plastic core of GILSULATE fused on by the pipe's own heat
ZONE 2—a sintered zone of GILSULATE particles. An excellent insulator, moisture-proof.
ZONE 3 — GILSULATE granules provide a final zone of thermal insulation.

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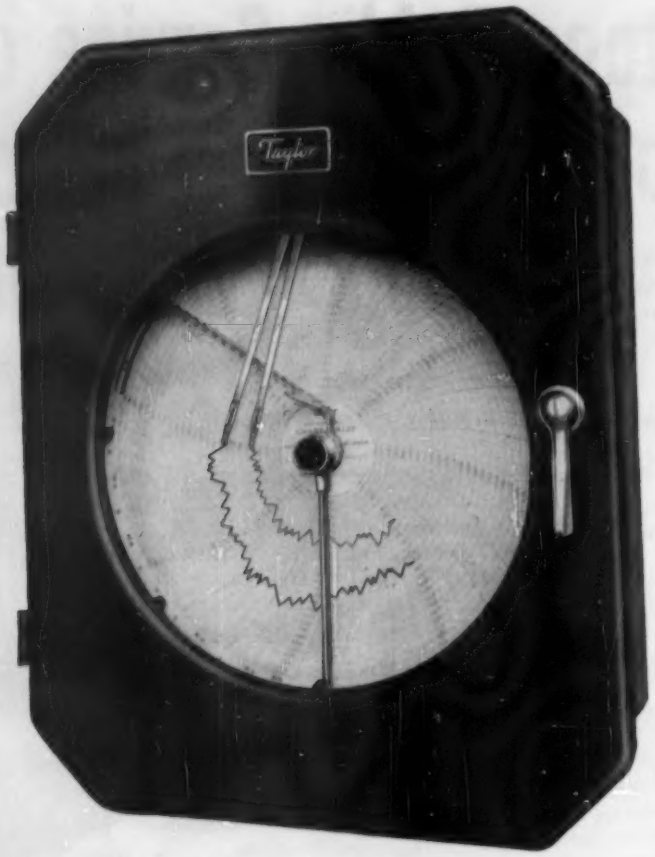

Put the finger on waste

The Taylor Recording Thermometer gives you a continuous chart record—your best check on the efficiency of both operators and equipment. It indicates when and where waste in heating or cooling media occurs, enabling you to effect improvements in operating conditions and greater operating economy. Chart records help you trace down faulty operation months after the error has occurred.

Taylor Recording Thermometers come in one, two or three pen models. Two pen recorders are ideal for checking temperature rise or fall between two points in a circulating system such as inlet and outlet brine lines, condensers or other related temperatures in the same or similar units. Three pen recorders are particularly suitable in steam power generation. For example, for recording steam inlet, condensate, and circulating-water outlet temperatures in the operation of a condenser; or flue-gas inlet, flue-gas outlet and air-inlet temperatures on air preheaters.

Actuation of these Taylor Recorders is by mercury, vapor, gas or organic liquid, depending on the requirements of the particular application and conditions. In the mercury actuated system Taylor ACCURATUS* Tubing compensates for variations in temperature along the tubing, thus extending the advantages of mercury to applications requiring long lengths of connecting tubing. Its 18-8 stainless steel construction is corrosion resistant to a wide variety of atmospheres, rugged and yet very flexible. Hundreds of standard charts available within the limits of minus 125° to +1200°F. Consult your Taylor Field Engineer for details, or write for **Catalog 76J.** Taylor Instrument Companies, Rochester, N.Y., or Toronto, Canada.

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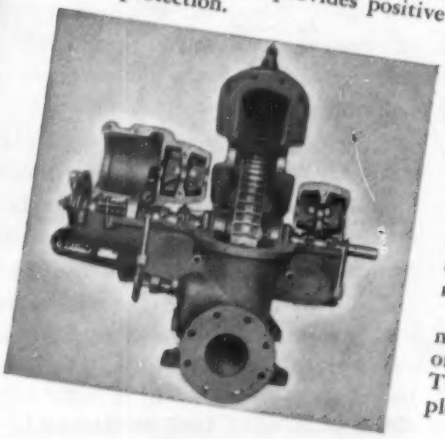
IN HOME AND INDUSTRY

TERRY

PROTECTION OF TURBINE BLADES made possible by nozzle location

The Terry Solid-wheel Turbine is of the impulse, helical flow type. The steam issues from an expanding nozzle at high velocity and enters the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is returned to the wheel several times until practically all of the energy has been utilized. This principle makes possible the efficient use of steam in a single-piece, almost indestructible wheel.

In the Terry Solid-wheel Turbine, the steam enters the buckets in a direction at right angles to the shaft, as shown above. This design eliminates the need for close clearances and provides positive blade protection.



The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, projecting rims on each side of the buckets prevent damage to the blades even though external thrust should move the wheel.

This is only one of the many important features of the Terry Solid-wheel Turbine. Write for complete details.

THE TERRY STEAM TURBINE CO.
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Memo

Send for a copy of bulletin S-116 which describes the many advantages of the Terry Solid-wheel Turbine.

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VALVES, FITTINGS and FLANGES

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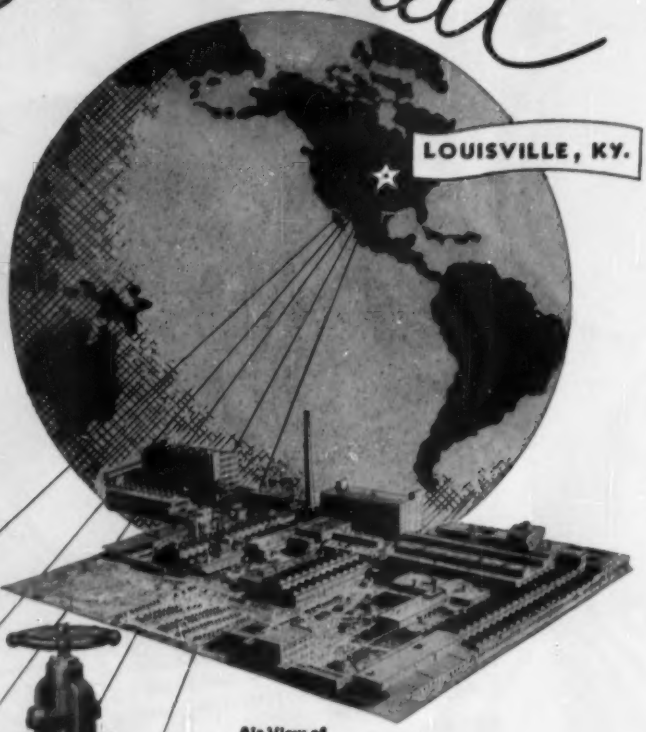

Air View of
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TO AMERICAN BUSINESS...

Thanks for Taming a Wild Horse

This is a message of appreciation to American industry. The occasion for the message is the completion of our eighth annual McGraw-Hill Survey of Business' Plans for New Plants and Equipment.

To a considerable degree, our appreciation is personal. It goes to the companies whose cooperation made our survey possible. Twice as many companies as in any previous McGraw-Hill annual survey carefully answered our questions about their plans to invest in new producing facilities. They gave a great deal of expensive time to the job. The cooperation of these companies, which employ nearly eight million workers, put the results of our survey on the firmest footing, in terms of coverage, it has ever had. For this cooperation we are most grateful.

But our appreciation is much more than personal. It extends in even greater degree to the kind of planning of investment in new plants and equipment which our survey revealed. The nature of this planning holds out promise that American industry is on the way toward bringing under control what historically has been one of the most upsetting forces in the American economy—the violent fluctuations in business capital investment. Progress in ironing out these fluctuations gives occasion for public gratitude.

A full report of the results of the eighth annual McGraw-Hill Survey of Business' Plans for New Plants and Equipment will be sent to anyone requesting it from the Department of Economics, McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York 36, N. Y.

Very Good Business News

The part of our surveys that attracts the widest interest is the news they give about immediate business prospects. And this year the news is very good. The survey results indicate that American business as a whole plans to invest $29.5 billion in new plants and equipment this year. That is 5% more than was invested last year, and a new high for any year.

Plans for the years 1956-1958 are also remarkably encouraging in terms of the amount of investment in prospect. American business reports that it is already planning to spend within 3% as much for new plants and equipment in 1956 as in 1955. In the past, the expenditures planned for future years have always been sharply lower than those planned for the current year. This is understandable enough. It is sometimes impossible to anticipate all the expenditures that will be necessary a year or more hence. Thus the fact that plans are already made

to spend almost as much in 1956 as this year is very good news about business prospects. The level of investment now planned for the years 1957 and 1958 is also remarkably high—far higher than ever reported for years that far ahead in previous McGraw-Hill surveys.

Taking the Long View

The fact that these plans exist is of immense constructive significance. It clearly indicates that more and more, and now in dramatic degree, American business is taking the long view in making its plans for capital investment. It is developing a program which, if successfully carried out, will go far toward eliminating the habitual, destructive surging and sagging of what is in effect the central power house of our economic system—capital investment by business. Upon the level of this investment depends not only the general state of our prosperity but our progress in raising the American standard of living with new products and new and better industrial processes.

Seven years ago, when we first asked industry to estimate its capital spending beyond the current year, only a small minority of companies could give us any estimates at all. This year, 87% of the cooperating companies—and it was a far larger number of companies—could comply with our request for estimates for the years 1956-1958.

It Pays to Bet on Growth

A number of developments help explain the increase in long-range planning of capital investment. One is the increasing technical complexity of American industry. It often takes longer, in this complicated age, to work out a successful installation of new plants and equipment. Another reason for long-range planning is American business management's increasing conviction that it pays to bet on the demonstrated capacity of the American economy to grow over the long pull. With this goes a corresponding determination not to let short-term business fluctuations upset individual company plans for growth through addition of new plants and equipment. An additional factor, and one of great and increasing importance, is the sense of public responsibility on the part of American business leaders who want to help prevent destructive swings in the levels of new investment.

It cannot be too strongly emphasized that there is still nothing automatic about the carrying out of these long-range plans for business spending. Actual expenditures are still governed in major degree by the general health of our economy. This is fully attested by the fact that the current business recovery has led to a substantial upward revision of the investment plans reported to us last fall when we made a preliminary check of plans for 1955. Either private economic excesses or a reversal of the recent improvements in federal tax policy could gravely upset realization of present plans. Fortunately, neither of these possibilities seems to be an immediate threat.

The very fact, however, that American business management has made these plans and will do its utmost to carry them out is a development of tremendous constructive importance for the American economy. It means that major efforts are being made to tame what historically has been an economic wild horse—the process of capital investment by business. Both for doing it, and for telling us about it in our annual surveys, we extend to American industry our sincere thanks.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

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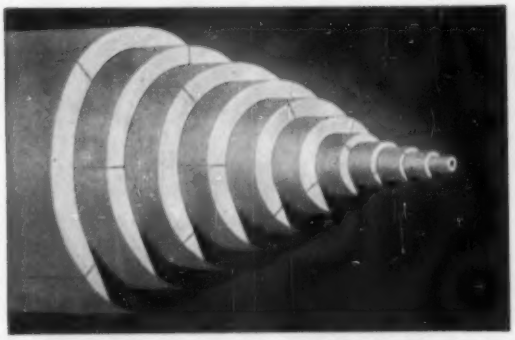
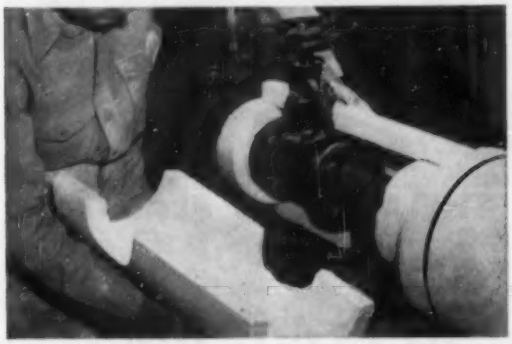


Snug nesting where necessary. O. D.'s of Kaylo insulation correspond to O. D.'s of standard pipes from ½" to 24", assuring proper fit and nesting where necessary.



Easily cut with ordinary tools. Kaylo is light-weight and so workable that it can be removed and replaced for line inspections without waste.

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Kaylo is made both as block and as molded pipe insulation with the widest range of sizes, forms and thicknesses of any high-temperature insulation. Now distributed by Owens-Corning Fiberglas Corporation, it provides, together with Fiberglas* Industrial Insulations, the most complete and versatile line of plant insulations available. For complete technical data, see our listings in Sweet's File, Chemical Engineering Catalog, or Refinery Catalog, or write: Owens-Corning Fiberglas Corporation, Dept. 186-F, Toledo 1, Ohio.

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2210 West 12th Avenue — Vancouver 9, B. C.

WATER SERVICE LABORATORIES, INC.
Water Treatment for corrosion control in buildings, boilers and air conditioning systems—Chemical Laboratory Services—Consultation.
New York—Philadelphia—Washington, D. C.

THE J. G. WHITE ENGINEERING CORPORATION
Design-Construction-Reports-Appraisals
80 Broad Street, New York 4

WHERE TO BUY

Featuring additional products, specialties & services for power plants

Attention...

EMPLOYMENT ADVERTISERS!

Effective with the July issue, a new section will start in POWER. We will head this section: EMPLOYMENT OPPORTUNITIES. All Displayed Employment Opportunity advertising will be placed in this new section, with the exception of those advertisers who contract for run-of-book position. Advertising in the EMPLOYMENT OPPORTUNITIES section will be billed at the new open rate of $25.00 per inch. Contract rates furnished on request. Ads are subject to Agency Commission.

For ful information write:

POWER
Classified Advertising
330 West 42nd Street,
New York 36, N. Y.

CLASSIFIED SEARCHLIGHT SECTION ADVERTISING

EMPLOYMENT • BUSINESS • OPPORTUNITIES • EQUIPMENT—USED or RESALE

UNDISPLAYED RATE

$1.65 a line. Minimum 3 lines. To figure advance payment count 5 average words as a line. (See ¶ on Box Numbers.)

POSITION WANTED undisplayed rate is one-half of above rate, payable in advance.

BOX NUMBERS count one additional line.

INFORMATION

DISCOUNT OF 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

EMPLOYMENT ADVERTISING New Employment Opportunities Section for Displayed ads starting July issue. For further details see announcement ad opposite page.

DISPLAYED RATE

The advertising rate is $17.90 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured ⅛ inch vertically on one column, 3 columns—30 inches —to a page. PR

NEW ADVERTISEMENTS, N. Y. Office, 330 W. 42nd St., N. Y., for the July issue closing June 13th.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42 St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITION VACANT

Operations Assistant: Graduate Engineer, at least two years utility operating experience. To work under direction of Vice President in analysis of property operations of diversified utility. Specific assignment—to improve operations and effect economies. Submit complete resume and starting salary. P-6875, Power.

POSITIONS WANTED

Power Plant Superintendent, age 33, married, technical education, 10 years experience in the operation and maintenance of steam-electric power plants. Understands personnel problems. PW-6009, Power.

Mechanical Engineer will soon go on mandatory retirement at 65 from large oil Co. Not ready for the rocking chair. Health very good. Looking for active employment in interesting engineering work. Lifetime experience mechanical, power and petroleum engineering, both office and field. Would prefer southern or midwestern location but interested in any attractive proposition regardless of location. PW-6602, Power.

Graduate Engineer excellent chemical and mechanical background in steam, pharmaceutical and industrial chemical plant design, construction and operation. Comprehensive experience ranges to responsibility at project level and client sponsor. Presently employed but seeking change to utilize talents at maximum level with fair assurance of continuity. PW-6596, Power.

Shift Engineer on high pressure boilers & turbines wishes to relocate. Age 40. 7 years turbine operating experience. PW-6480, Power.

DIESEL ENGINE

One 180 H.P. Worthington Vertical 3 cylinder 2 cycle diesel engine complete with 5' diameter fly-wheel, pulleys, clutch, exhaust, etc. Engine now running in good condition and for sale only because it is being replaced by electric motor. Price $5,000. Can be inspected at plant situated at Price, Louisiana on GM&O Railroad, approximately 75 miles by highway from New Orleans.

WASHINGTON SAND & GRAVEL COMPANY
415 No. St. Patrick Street
New Orleans, Louisiana

FIELD SALES SUPERVISOR

CENTRAL STATES

A Lifetime Business Future

Unlimited potentials with more than 21 years old firmly established corporation. Travelling expenses and override commissions given on all business received from 15 territories in which we have fifteen active representatives. Applicant must be hard working, constructive, executive, leader type. Must have successful experience in hiring and training. Experience in the sale of power plant chemicals or equipment necessary. Age 40-45. Write fully. Replies held in confidence.

P-6543, POWER

330 W. 42nd St., New York 36, N. Y.

CHIEF POWER SYSTEM ENGINEER
CHIEF POWER PLANT ENGINEER
CHIEF TRANSMISSION & DISTRIBUTION ENGINEER
CHIEF ELECTRIC UTILITY ACCOUNTANT

for a National Power System in Central America, consisting of new high pressure 30,000 KW steam generating plant, present 10,000 KW diesel generating plant, 110 miles transmission line, and distribution systems in one large city and fifteen small towns. Minimum 5 years experience. Preferred age 30 to 50 years. Good working conditions with initial contract for two or three years and opportunity for advancement. Working knowledge of Spanish desirable. All applications will be acknowledged. In reply state age, detailed experience, education, salary expected, and availability date. These positions will be filled between July and December 1955.

P-6403, POWER

330 W. 42nd St., New York 36, N. Y.

MECHANICAL ENGINEERS

Recent Mechanical Engineering Graduates wanted by middlewest electric utility. Good starting salary. Excellent opportunity for advancement with this progressive Company. Company paid pension, liberal vacations and other benefits.

Contact: Personnel Director

INTERSTATE POWER COMPANY
Dubuque, Iowa

ELECTRICAL ENGINEER—TRAINEE

To assist supervisor in Maintenance and construction work in a sizeable mid-western educational institution. Applicant should have a degree from an accredited engineering school and preferably some practical experience. Employee benefits include a pension plan, paid vacation, sick leave, etc.

P-6573, POWER

520 N. Michigan Ave., Chicago 11, Ill.

WANTED
MERCURY ARC RECTIFIER

1000 or 1200 KW

W-6533, POWER

330 W. 42nd St., New York 36, N.Y.

OPENING AVAILABLE AT LONG ESTABLISHED MEDITERRANEAN COPPER PROPERTY

ASSISTANT CHIEF ENGINEER

Age limit 45 preferably about 35. Must be graduate mechanical, chemical or civil engineer with natural mechanical ability, excellent practical and supervisory and some construction experience, for charge under Chief Engineer of all shops, foundry, mobile equipment including loading, marine, railway and construction; maintenance and repair of all types of equipment; 7250 KVA diesel generating plant.

Forward with initial reply complete educational and experience records, list of references, age, marital status, number and age of children, photo (optional). Company offers three year contract, furnished house, transportation self and family, liberal vacations. Excellent climate, living conditions, medical and hospital facilities. School to 14 years. Non-contributory pension plan. Salary open.

P-6210, POWER
1111 Wilshire Boulevard
Los Angeles, California

HYDRAULIC TURBINE SERVICE

Cavitated and Damaged Runners Repaired

Cast Iron, Cast Steel,
Bronze and Stainless: Emergency
Services: Inspection and Supervision
Services: 30 years experience

- Use of Stainless Steel for cavitation repairs for long life
- Work performed in place on runners where damaged areas are accessible
- Wicket gate stems and contact edges built up and machined
- Turbine Shafts straightened

SERVICE ANYWHERE

Write for Bulletin No. 501

Welding Engineers, Inc.

Norristown, Pa. Phone: 8-6900

GET 2nd ENGINEER PAPERS IN 1 YEAR

(Yes, get better stationary engineers License!)

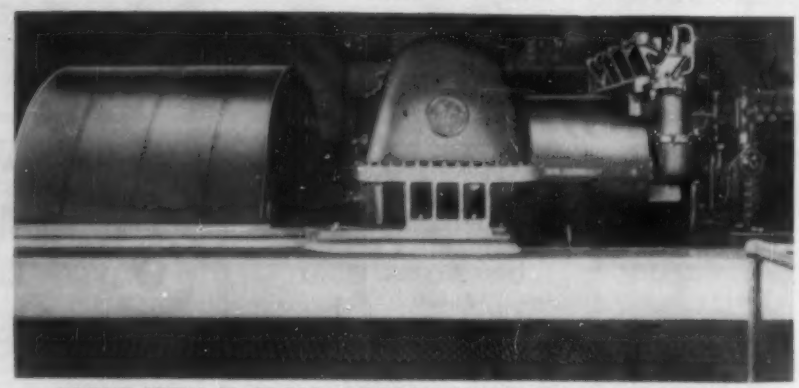
No correspondence school bother. Nationally-known Chief Stationary Engineer Frederick C. Walker's 100-Question, 100-Answer Bulletins give you the straight dope quick. Send $3 to Walker & Collins, 524 Ashland Ave., Buffalo 22, N. Y. for first set today. Keep working. Save year.

3750 KVA. — G. E., 400#, 750°, 2300-4160-V., TURBINE-GENERATOR

A VERY HIGH GRADE MACHINE: EXCELLENT CONDITION

WRITE US FOR COMPLETE INFORMATION TODAY.

Complete Unit: 2-Pass Surface Condenser.



Switchboard With Instruments Direct Connected Exciter.

ABOVE VIEW IS FROM A RECENTLY TAKEN PHOTOGRAPH.

We Carry Large Stocks of Turbine Sets, Diesel Engines, Boilers. In Turbines we cover Units from 500-KW. to 10,000-KW. Also Large Stocks of Diesels and Boilers.

Always Secure Our Prices Before Placing Your Orders.

Telephone, Write or Wire.

CHARLES WEAVER, M. E.
19701 JAMES COUZENS HIGHWAY
DETROIT 35, MICHIGAN

Broadway 3-1901

ELECTRIC EQUIPMENT CO.
P. O. BOX 51 • ROCHESTER 1, N. Y.

JUNE SPECIAL—F.O.B. Detroit • **4—1500 KW Motor Generator Sets**
2—Westinghouse • 2—Gen. Elec. • 250 V. D.C. 13,800-4160-2400V A.C., Syn.

DIESEL UNITS

400 KVA. Elliott-Ingersol Rand, 600 RPM
250 KVA. GE-Chicago Pneu. 720 RPM
187 KVA Al. Chal.-Chicago, Pneumatic, 720 RPM.
62½ KVA (2) International Diesel Units; mounted on trailer

BOILERS

1000 HP. (2) B&W. 160#
600 HP. (2) B&W. 200#
250 HP. (2) B&W. 160#

TURBO GENERATORS

125 KVA. GE. 3/60/240/480 volts, non-cond; 0 to 30# back pres.
250 KVA GE. 3/60/220/480 volts, 400# 30 to 110# bp.
250 KVA GE. 3/60/220/480 volts, 100/150#, 0 to 15# bp.

POWER PLANT EQUIPMENT CO.
39 CORTLANDT ST., NEW YORK, N. Y.

—TRANSFORMERS—

BOUGHT AND SOLD

We carry a large stock of rebuilt and guaranteed transformers, and invite your inquiries.

Custom-built transformers and coils manufactured to your specifications.

Expert Repair Service—all makes and sizes of transformers rewound, repaired and redesigned. Ask for our price schedule.

THE ELECTRIC SERVICE CO., INC.
5318 Hetzel St. Cincinnati 27, Ohio
40 Years' Dependable Service

FOR SALE

Detroit Roto Stoker

Grate 9'-3" x 11'-4" long with 3 feeders—readily altered to 2 feeders and grate shortened. No. F. D. pan included. Cinder return blower included.

New 1945. Used 45 days. May be inspected before dismantling. Price $1500.00 F.O.B. Truck Toledo.

HUNT FOODS OF OHIO, INC.
926 Dearborn Ave., Toledo 1, Ohio

RE-NU-BILT
GUARANTEED

ELECTRIC POWER EQUIPMENT

D. C. MOTORS

Qu.	HP	Make	Type	Volts	RPM
1	3000	West.	Tandem	600	600
1	2200	G.E.	MCF	600	400/50
1	1400	G.E.	MCF	600	63/190
1	1200	G.E.	MCF	600	750/95
1	1000	G.E.	MCF	600	350/55
1	940	Whse.	QM	250	140/17
1	900	Whse.		250	450/55
1	825	Whse.		250	95/190
1	600	Al. Ch.		250	400/800
1	500	Whse.	CC-216	600	300/90
1	500	G.E.	MCF	230	300/90
2	450	Whse.		550	415
1	350	West.		250	340/95
1	200	Whse.	CB-511-3	250	400/800

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	H.P.	Make	Type	Volts	Speed
1	1500	G.E.	MT-498	2300	360
1	1500	ABB		2300	720
2	1000	A.C.	Mill	2300	240
1	800	G.E.	MT	2300	293
1	500	G.E.	MT-412	2200	580
1	500	G.E.	M-574T	6900	900
1	500	Whse.	CW	550	350
1	400	Whse.	CW-960A	440	1170
1	400	Whse.	CW	440	514
1	400	Whse.	CW-1218	2200	435
1	350	G.E.	MT-442 Y	2200/4000	253
2	350	G.E.	IM-17A	440/2300	720
1	250	G.E.	MT-424-Y	4000	257
1	250	G.E.	MT-5595	2200	1800
1	250	Al.-Ch.		550	600

SQUIRREL CAGE

2	650	G.E.	FT-559BY	440	3570
2	450	Whse.	CS-1420	2300/4150	354
1	300	Whse.	CS	440	1170
1	200	G.E.	IK-17	440	580
3	200	G.E.	KT-557	440	1800
1	150	Whse.	CS-8568	440	880
1	150	Whse.	CS	440	580
1	150/75	G.E.	IK	440	900/450
2	125	Al. Ch.	ARW	2200	1750

SYNCHRONOUS

1	4350	C.W.	3501-SL	13800/6900	514
2	2100	G.E.	ATI	2300	360
3	1750	G.E.	ATI	2300	3600
3	2000	Whse.		2300	120
2	725	G.E.	ATI	2200/12000	600
1	560	Ideal	SSJ	2300/4160	1800
1	500	Whse.		440	900
1	450	Whse.		2200	128.5
1	450	Whse.		2200	450
1	400	G.E.	T8	2200	400

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
2	2000/2400	G.E	450	250/300	2200/4600
1	2000	G.E.	450	600	2300/4600
1	2000	G.E.	600 25cy	600	11000
2	2000	G.E.	514	600	6600/13200
1	1750/2100	G.E.	514	250/300	4800/2400
1	1500	G.E.	720	600	6600/13200
1	1500	C.W.	514	20/115	4000/13000
2	1000	G.E.	720	600	2300/4600
1	1000	G.E.	900	260	6600
1	750	C.W.	514	20/115	2300
1	750	G.E.	900	125/250	2200
1	600	G.E.	720	250	440/2300
1	560	Whse.	1380	115/230	2300

TRANSFORMERS

Qu.	KVA	Make	Type	Ph.	Voltages
1	5000	Whse.	OISC	3	23000x26400
1	3000	Wagner	HPW-20	3	26400x2400
2	4200	G.E.-Fur.	FOWT	3	13800x200/87
3	2000	G.E.	HVDDJ	1	66000/13800
3	667	G.E.	HD	1	13800x2300
3	1000	G.E.	HVDDJ	1	2400x480
6	1000	Wagner	OISC	1	13200x460

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltages
1	12500	Whse.	60/25	13200/13200
1	5000	G.E.	60/50/60	6600/11000/6600
1	3000	G.E.	60/25	2300/2300/4000
2	2500	G.E.	25/62.5	2300/2300
1	1000	G.E.	25/58.3	4400/2300
1	500	Al. Ch.	2500	11000/2300

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	4000	G.E.	Condensing 425 — 750 F.T.T. Surface Condenser 2/60/2300, 4000 V Direct conn exciter.
1	1500	Whse.	Auto. extraction 190 lbs.—660° F.T.T. 60 lb. extraction 3/60/240 V. Dir. conn. Exc.
1	1000	Moore	Auto-Ext. Cond. 175/200# I.S.P. 5/30# G. Ext. Surface Condenser—3/60/2300.
1	1000	G.E.	Non-condensing 175/200 lbs. I.S.P. 5/30 lbs. G.H.P., 450/3/60.
1	750	G.E.	Condensing 265# I.S.P. 440V. 3 ph. 60 cy.—New—1944.

BELYEA COMPANY, INC.
43 Howell St., Jersey City 6, N. J.

CHECK WITH WAGNER FIRST

"Certified Rebuilt" Motors and Generators

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
300	Allis Ch. b.b.	EW	250	1000
200	Allis Ch. b.b.	EW	250	850
150	Whse.	SK-201	230	300/900
150	Whse.	SK-184	230	850
150	Gen. Elec,.	RC-16	230	1700
100	Reliance	1050-T	230	400/1200
100	Whse.	SK-173	230	850
100	Reliance	051T	550	1000/1500
75	Cr. Wh. TEFC	53H	250	850
75	F. Morse b.b.	DH-140	115	1400
50	G.E. dynam. (4)	TLC58	250	1000/3500
50	Whse. (2)	SK-143	230	850
40	Whse. (2)	SK-133	230	850
35	Whse.	SK-163	230	300/900
30	Imperial b.b.	100	230	400/1600
30	Star b.b. (2)	8B	230	1750
25	L. A. TEFC	HNA	230	850
25	Whse.	SK150	230	300/1200

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
400	Whse.*	2300 AC	250 DC
380	Allis Ch.	2300/440 AC	125/250 DC
250	Allis Ch.	2300/440 AC	250 DC
200	Whse.*	220/440 AC	55 DC
200	Gen. Elec.*	220/440 AC	125 DC
200	Whse.*	220/440 AC	250 DC
150	Gen. Elec.	220/440 AC	125 DC
150	Whse.	2300/440 AC	275 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
105	Century b.b.	220/440 AC	70 DC
100	G.E.*	2300/440 AC	125 DC
100	Whse.	220/440 AC	250 DC
75	F. Morse b.b.	220/440 AC	125/250 DC
75	Cent. b.b.	220/440 AC	125 DC
60	Gen. Elec.*	220/440 AC	60 DC
60	Whse (2)	220/440 AC	300 DC
50	Gen. Elec.	220/440 AC	125 DC
50	Whse.	220/440 AC	250 DC
30	Gen. Elec.	220/440 AC	250 DC
30	Gen. Elec. (2)	220/440 AC	125 DC
30	F. Morse b.b.	220/440 AC	24 DC
25	Whse.	220/440 AC	125 DC

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
200	Al. Ch.	MECW	125/250	1200
250	Allis Ch. b.b.	EW	250	1200
175	Allis Ch. b.b.	EW	250	900
150	Gen. Elec.	RC	250	1800
135	Whse.	SK-184	250	1150
105	Century b.b.	1500 amp.	70	1200
100	Whse.	SK-173	250	1150
100	Whse.	SK162	250	1800
100	Allis Ch.	E	125	1200
100	Reliance	051T	400	1200
75	Cent. b.b.	D109X	125	1150
75	F.M. b.b.	DG	125	1800
75	Cr. Wh. bb (2)	CCD	250	1150
60	Whse. b.b.	SK121	300	1200
50	Whse. (2)	SK-143	250	1150
40	Whse.	SK-133	250	1150
35	Gen. Elec.	RC22	125	1500
25	Whse.	SK93	125	1750
25	C.W. b.b.	CCD	250	1150

A. C. MOTORS — 60 CYCLE

HP	Mfr.	Type	Volts	Speed
750	G.E.	Synch.	2300	514
700	Allis Ch.	Sq. Cage	440	900
650	Allis Ch.	Slipring	2300	900
600	G.E.	Slipring	2300/440	600
600	G.E.	Sq. Cage	4000	1800
560	G.E.	Slipring	2300/440	450
500	G.E.	Synch.	440	900
450	Allis Ch.	Synch.	440	450
400	Whse.	Sq. Cage	2300	514
400	G.E.	Synch.	440	450
350	Whse. (2)	Slipring	2300	450
300	G.E. (2)	slipring	2300/440	720
300	El. Machy	Synch.	220/440	360
300	Al. Ch.	Sq. Cage	2300/440	720
300	Whse.	Synch.	2300/440	600
300	G.E.	Slipring	440	300
250	G.E. b.b.	Sq. Cage	2300	900
250	Gen. Elec.	Synch.	220/440	450
250	G.E.	Synch.	220/440	720
250	Whse. (2)	Sq. Cage	2300/440	1200
250	L.A. (2)	Sq. Cage	2200	1800
225	G.E.	Synch.	220/440	900
200	Whse.	Slipring	220/440	900
200	Gen. Elec.	Sq. Cage	220/440	1200
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	440	450
200	Gen. Elec.	Sq. Cage	2200/440	720
200	Cr. Wh.	Sq. Cage	220/440	3600
200	Whse.	Sq. Cage	2300/440	900
200	E. M.	Synch.	220/440	1200
200	E. M.	Synch.	220/440	514
175	G.E. (2)	Synch.	220/440	720
150	El. Machy.	Synch.	220/440	360
150	Whse.	Sq. Cage	220/440	900
150	G.E.	Synch.	220/440	450
150	Allis Ch.	Slipring	2300/440	720
150	G.E. (2)	Sq. Cage	2200/440	720
150	Rel. b.b.	Sq. Cage	220/440	1800
150	Allis Ch.	Sq. Cage	440	450
150	G.E. vertical	Slipring	4000/2300	1200
125	G.E. TEFC	Sq. Cage	220/440	3600
125	Whse.	Sq. Cage	220/440	900
125	Rel. TEFC	Sq. Cage	220/440	1800
125	G.E.	Slipring	220/440	450
125	E. M.	Synch.	220/440	1800
125	Allis Ch.	Slipring	220/440	900
100	G.E.	Slipring	220/440	514
100	G.E.	Slipring	220/440	900

A. C. GENERATORS — 60 CYCLE

KVA	Mfr.	Type	Volts	Speed
1000	Whse. syn cond		4000/2300	900
625	Gen. Elec.	ATB	2300	450
600	Gen. Elec.	ATB	480	900
485	Allis Ch.	1 brg.	480	400
313	Gen. Elec.	ATH	240/480	450
275	G. E. 25 cycle	ATI	480	750
250	El. Machy.		480	720
225	Gen. Elec.	ATI	240/480	900
160	Whse.		2300/480	600
125	Allis Ch.		240/480	900
75	El. Machy.		2300	900
56	G. E.	ATB	240/480	1200
27½	Whse.		240/480	1200

• These are only partial listings of our large stock — send us your inquiries for prompt attention and complete quotations. Quick shipment—fair prices—fully guaranteed. We save you time & money—safely!

SEND FOR WAGNER MOTORGRAM P-102

ARTHUR WAGNER COMPANY
1435 W. RANDOLPH ST.
CHICAGO 7, ILLINOIS
TELEPHONE MONROE 6-7409

BREW WOLTMAN *Offers*—

4000 KW 80% PF G.E. Non-Cond., auto extr. Turbo Gen. 3-60-13800 V., 3600 RPM 600 PSIG 750° TT, 135# extr., 50# max. BP. NEW.

3500 KW 80% PF West. Cond. Turbo Gen., 3-60-2400/4160 V., 3600 RPM 400 PSIG, 750° TT, dir. con. exciter, surf. cond. New 1948.

300 KW 80% PF G.E. Non-Cond., Turbo Gen. 3-60-480 V., 3600 RPM 150 PSIG, 5# B.P., dir. con. exciter.

Full line power equipment—send us your inquiries.

BREW, WOLTMAN & CO., INC., 50 Church St., New York 7

SAVE 50 TO 80% ON THE EQUIPMENT YOU NEED!

with CHICAGO ELECTRIC GUARANTEED "REBUILTS"

WIRE WRITE OR PHONE CAnal 6-2900

MOTOR GENERATOR SETS

KW	Make	A.C.	D.C.
1000	G.E.	13200	600
500	Westg.	4600	250
400	G.E.	2300	775
400	Al.-Ch.	2300	120/240
250	Westg.	2300	125/250
200	G.E.	2300	250/275
200	Westg.	4160/2300	275
200	Ridgeway	2300	250
170	G.E.	440	125
150	G.E.	2300	125/250
150	Al.-Ch.	2300	275
150	Westg.	2300	1250/250
150	G.E.	440	275
100	G.E.	2300	250
100	Westg.	440	125
100	Elec. Mch.	440	125
100	G.E.	440	125
90	G.E.	440	60
75	G.E.	440	125
50	Refiance	440	250
50	Ideal	2300	250
50	Westg.	240	125

SLIP RING MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

HP	Make	Type	Speed
2000	*G.E.	MT	600
1250	*G.E.	MT-30	240
1000	*Westg.	CW	450
700	*Al-Ch.	ANY	750
500	G.E.	I-17A	600
500	Westg.	CW	1150
400	*G.E.	MT-412	450
400	*G.E.	IR-15A	1800
300	*G.E.	MT-509	750
300	Westg.	HP-15H	600
250	*G.E.	I-17B	450
200	G.E.	IK-15B	900
200	G.E.	IM-17	600
150	G.E.	MT-549	1800
150	*Al-Ch.	ANY-20F1	1500
150	Westg.	CW-868A	750
150	* Westg.	CW	450
135	G.E.	IM-15A	600
100	G.E.	MT-556	900
100	G.E.	MT-560	720
100	G.E.	IM	600
75	G.E.	MT-347	1500
75	G.E.	MT-350	900
75	G.E.	MT-550	720
75	G.E.	IM	600
60	*Westg.	CW-762C	900
50	Westg.	CW-626A	1200
50	G.E.	MT-336	900
50	G.E.	MT-346	720
50	G.E.	IM	450

SQUIRREL CAGE MOTORS

3 phase, 60 cycle, 220 or 440 volts. (*2300 volts or higher)

HP	Make	Type	Speed
1250	*Al.-Ch.	ANW	3600
1250	*Al.-Ch.	ANW	1200
800	*Westg.	CS	3600
800	*Westg.	CS-1463	1800
700	*Westg.	CS	1200
700	Al.-Ch.	AN	900
500	*Al.-Ch.	6816-8W	1800
500	G.E.	KT-424	450
400	G.E.	KF-539	3600
400	G.E.	KT-424	900
350	Ideal	A	1800
300	*G.E.	K-6344Y	1200
300	G.E.	K-6353 TEFC	720
250	G.E.	KT-559B	1800
250	Westg.	CS875B	1800
250	*L.-Allis	OGK-148	720
250	*G.E.	IK	600
250	G.E.	IK-17A	600
250	West.	CS-14	514
225	*G.E.	IK-12B	1800
200	*G.E.	FT-549Y	3600
200	*Cr. Wh.	8C	900
200	Al-Ch.	ARWWT	900
200	*Westg.	CS	600
200	Al.-Ch.	AN	514
150	G.E.	IE-12B	1200
150	Westg.	CS-7728	1200
150	*Westg.	CS-8120S TEFC	1200
150	Westg.	CS-876C TEFC	900
150	Wagner	RP2-31V	900
150	*Westg.	CS	600
125	*Westg.	CS-771 Sppf.	1800

D. C. MOTORS — 230 Volt

HP	Make	Type	Speed
250	Westg	SK-220	450/600
200	Westg	SK201	650
200	Cr. Wh	CM	500
175	G.E.	ELC	750
100	G.E.	MPC	400/800
100	G.E.	RC-34	2500
100	G.E.	RC-19	575
100/150	G.E.	MCF	350/1000
75	G.E.	BCP-34	1750
75/25	Westg	SK-151	400/1600
50/120	G.E.	MCF	250/1000
50	Cr. Wh	CMC	700/1100
50	G.E.	DLC	650
35	Westg	SK-150	350/1000
30	Cr. Wh	CCM-504	450
30/40	G.E.	CD-115	500/1500
25	G.E.	BC-32	800
25	Westg	SK-123	575
20	Star	SB-16	1750
20	Westg	SK-110	750
15	Westg	SK-102	400/1600
10/15	Reliance	185T	400/1600

CHICAGO ELECTRIC

Carries a Complete Stock of New & Rebuilt Motors and Electrical Equipment. If what you need is not listed wire, write or phone giving particulars, or send for Stock list.

CHICAGO *Electric Co.* **1320 WEST CERMAK ROAD, CHICAGO 8, ILL.**

37 Years Dependable Service

SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
600	2300	Whse.	450
500	2300/4000	G. E.	600
450	440	Whse.	514
450	440	Whse.	720
300	2300/440	G. E.	720
300	440	G. E. (hoist)	600
300	2300	G. E.	360
300	440	Whse.	1200
250	440/220	Whse.	600
250	550/440	G. E.	1200
200	440/220	Whse.	514
150 (2)	440/220	G. E.	720
150	2300/440	G. E.	600
135	440/220	G. E. (hoist)	600
135	440/220	G. E.	900
135	550/440	G. E.	1200
125	2300	G. E.	600

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2300/440	G. E.	ATI	720
375	440/220	Whse.	O	900
350	440/220	El. Mach'y.	Syn.	1200
300	2300/440	G. E.	TB	720
300	2300/440	G. E.	TB	1200
300	2300/440	G. E.	TB	720
250	2300/440	G. E.	TB	720
250	440/220	Whse.	HR	277
250	440/220	G. E.	ATI	600
125	440/220	Whse.	HR	600

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
800	2300	G. E.	FT	3600
650	2300/4000	Hilles	8C	1800
500	2300	G. E.		450
400	2300/400	Whse.	CS	720
350	2300	L. Allis	FS	1800
350 (2)	2300/440	G. E.	KT	1200
300	440	G. E.	IK	720
300	440/220	G. E.	KT	1800
300	2300/440	G. E.	IK	600
300	2300	G. E.	KT	1800
150	440/220	Whse.	CS	600
150	2300	Al. Chal.	AR	1800
150	220	Whse.	CS	1200
150	440/220	G. E.	IK	600
150	440/220	G. E.	KT	720
150	2300/440		KT	600

A. C. GENERATORS

1—320 kva. 600 rpm 2300/440/220 V., G.E.
1—300 kva. 900 rpm. 450/220 V., G.E.
1—300 kva. 600 rpm. 220/440 V. G.E.
1—200 kva. 720 rpm. 2300/440 V. G.E. (Ball)
1—187 kva. 1200 rpm. 2300/440 V., Whse.

CIRCUIT BREAKERS

2—3000 amp. GG E., 3 pole, 600 V.
2—1600 amp. ITE, 3 pole, 600 V.
6—FKM-135-2S, 600 amp., 15,000 V., G.E.
1—FKR-143, 1200 amp., 4000 V., G.E., del. sp. (new)

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
225	230	Whse.	SK	2270
150	230	Whse.	SK	1750
100	230	Whse.	SK	400/1200
90	550	G. E.	CD	1750

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	2300	Syn.	250
175	G. E.	220/440	Syn.	230
138	G. E.	440/220	Syn.	550/125
100	Al. Ch.	220/440	sq. ca.	540/120
100	Whse.	440/220	sq. ca.	135
75	G. E.	2300/440	Syn.	125
65	G. E.	2300/440	sq. ca.	250

TRANSFORMERS 60 Cy.

1—900 kva, Standard, 13,800-2300 V., 3 ph.
3—600 kva, Whse., 66000—2300 V.
1—350 kva, G. E., 13000—2300 V.
1—300 kva, G. E., 2300—575 V.
3—300 kva, G. E., 11000—2300 V.
2—300 kva, G. E., 4160—440/240 V.
2—150 kva, Al. Chal., 2400—240/480 V.
6—100 kva, Whse., 2400—120/240 V.

only partial listing

STEPHEN HALL & CO.

HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.

DIESEL GENERATOR SETS

3—1600 HP Fairbanks Morse Model OP 720 RPM, 1420 KVA FM 3/60/2400 volt generators. New 1949.

1—750 HP Superior 8 cylinder, 400 RPM, 500 KW Elec. Mchy. 3/60/2400 volt generator & auxiliaries.

1—400 HP Superior 4 cyl. 400 RPM Model VDSE, 250 KW, 3/60/2400 volt.

MISSISSIPPI VALLEY EQUIPMENT CO.
507 Locust St., St. Louis 1, Mo.

TWO (2) PACKAGE BOILERS

Fire tube type, new, unused, export crated, immediate delivery. Mfd. by Cyclotherm (Div. U.S. Radiator Corp., Oswego, N.Y.) each rated 500 HP, 17,250# steam per hour @ 212°. Model C-17,500D. Natural gas/light oil fired. Aux. equip. includes class "B" motors, oil immersed starters, non return valves, outdoor hoods, skid-mounted water feed pumps.

Substantial Discount for Immediate Cash Sale FOB Weehawken, N. J. Contact:

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BOILERS WANTED

Used Package type oil fired, water tube capacity 35,000 to 40,000 P.S.H., induced draft 125 lbs. pressure.

Also, used Package type oil fired, fire tube, 350 to 500 H.P., 125 lb. pressure.

Must pass rigid insurance inspection, give details, best price, location, when can be seen etc.

W-6646, POWER
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FOR SALE

MODERN 1000 KW Turbo-Generator

In excellent Condition

Non-Condensing, Steel case 80# back pressure .8 P.F., 3 phase, 60 cycle, 4160/2300 volts, alternating current, complete with accessories, switchboard, oil circuit breaker and direct connected exciter. Only operated alternately for six years. Ideal for Chemical, Rubber, Petroleum. Textile, Pulp and Paper, and Sugar Refining Industries.

NEWMAN & COMPANY, INC.
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DIESEL GEN. SETS

200 KW Cooper Bessemer DC, Model FB-6, air start, heat exchanger cooled. Direct coupled to: General Electric Generators, 120/240 volts, 750 RPM. Incl. Accessories.

ALJON ELECTRIC DIESEL CO.
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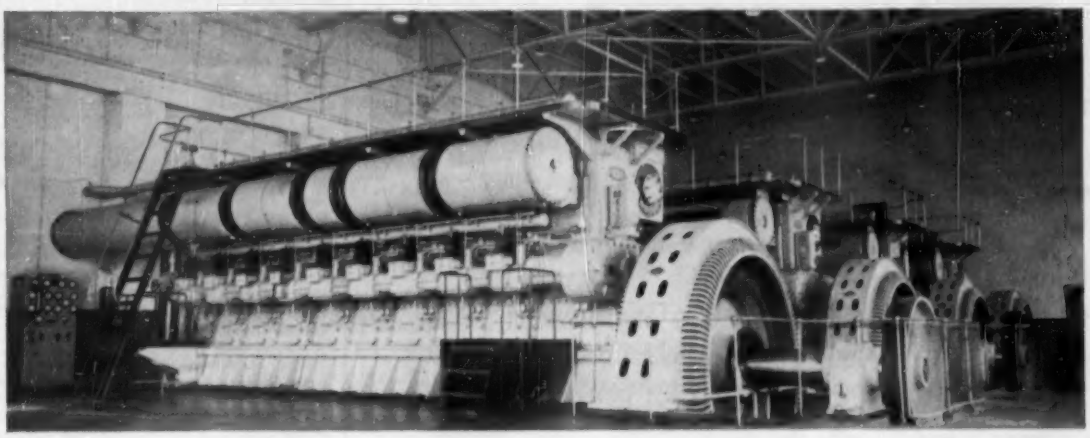
STerling 3-6515

FOR SALE
USED BOILERS AND MACHINERY

Two 25 ton Vulcan steam locomotives, 100 H.P. Kewanee, 60 H.P. Keeler, 40 H.P. Frick. Automatic O & S Powermasters, (one 20, one 50, and one 60 H.P.) Steam engines and power units.

ARTHUR S. YOUNG CO., INC.
KINZERS, PENNA.

8100 KVA DIESEL POWER PLANT
FOR SALE – Complete or As INDIVIDUAL UNITS



THREE (3) BUSCH-SULZER (NORDBERG) DIESEL ENGINES, 3060 HP, 9 cylinder, 2 cycle, 240 RPM, Type 9 DHB-27, direct coupled to: THREE (3) 2700 KVA, E. M. C. ALTERNATORS, 3/60/2300/4160 V.

Each Unit Complete with all Auxiliaries. NEW 1943—Can be inspected operating.

CAN BE PURCHASED FOR CASH, OR TIME, OR ON LEASE.

HEAT & POWER CO., INC.

60 EAST 42nd STREET • MUrray Hill 7-5280 • NEW YORK 17, N. Y.

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3 G. M. 200 KW DIESEL GENERATOR SETS

Reconditioned by U.S. Navy

EQUAL TO NEW

Complete with motor driven starting air compressors, air tanks, dead front type generator switch panels and all other necessary accessories.

ENGINES

G.M. Model 8-268A—8½X7—1200 RPM—air starting—complete with engine operating panels, heat exchangers, cooling pumps, filters, strainers, governors, pyrometers, etc.

GENERATORS

Westinghouse 200 KW 250 KVA—440/3/60—1200 RPM—80% P.F.—continuous—drip-proof enclosure—direct connected exciter.

SIZE AND WEIGHT

Each unit, mounted on a pre-fab sub-base, is 13' 9 3/16" long, 5' 10½" wide, approx. 8' high. Weight of engine and generator only, 17,700 lbs. Each unit, with all accessories, about 27,000 lbs.

CONDITION

No expense has been spared to put these 3 units in "equal to new" condition. Don't miss this opportunity to buy! Inspection can be made at our warehouse, Curtis Bay, Baltimore.

THE BOSTON METALS CO.

313 E. BALTIMORE STREET

BALTIMORE 2, MD CURTIS 7-5050

Rebuilt HEMPHILL Guaranteed EQUIPMENT

TRANSFORMERS 60 CYCLE

Qu	KVA	Make	Type	PH.	Voltages
2	3750	G.E. New	OISC	3	26400x4160
1	1000	G.E.	Auto	3	4150x2400
1	1000	Amer.	Pyranol	3	4150x480
1	750	G.E.	HT	3	4150x120/240
2	750	G.E.	H	1	4600x120/240
1	500	Kuhl	OISC	1	4600x2300
2	400	Pitts.	OISC	1	4150x240/480
1	333	G.E.	H	1	13200x220/440
3	200	G.E.	H	1	13200x440
3	150	American	OISC	1	2400/4160-240/480
3	75	G.E.	Pyranol	1	2400/4160-240/480

SYNCHRONOUS MOTORS

QU	HP	Make	Speed	Type	Volts
1	1400	G.E.	514	ATI	4150
1	1000	Whse.	235	MIII	2300
1	500	Whse.	450	HB	2300
1	300	EM	720	TEFC	2300
1	300	G.E.	600	ATI	600
1	208	Whse.	600	ATI	240
1	175	G.E.	720	ATI	2300
2	150	G.E.	1200	T8	4150
1	150	G.E.	1800	T8	220
1	150	Whse.	900	IBIG	220
2	130	Allis	380		2200
1	125	EM	900		4800
1	100	G.E.	900	T8	2200

SLIP RING MOTORS

QU	HP	Make	Speed	Type	Volts
1	500	G.E.	1200	M	2400/4150
1	400	Whse.	450	CW	550
1	250	Whse.	60	CW	440
2	200	Whse.	600	CW	440
1	200	G.E.	600	MT	440
1	150	A.C.	1800	AT RW	2300
1	100	G.E.	1800	IM	220
1	100	G.E.	600	IM	440
1	75	G.E.	600	IM	440
3	60	G.E.	1800	MT	220

MOTOR GENERATOR SETS

Qu	KW	Make	Speed	DC	AC
1	1000	G.E.	514	600	2300/4150 Syn
1	1000	Whse.	720	600	2300/4150 Syn
1	1000	Whse.	720	275	2300/4150 Syn
1	300	G.E.	1200	250	2300/4150 SR
1	300	G.E.	1200	250	2300/4150 Syn
1	200	Whse.	900	250	2300/4150 Syn
1	150	C.W.	600	125	230/460 V
1	100	G.E.	900	250	2300 Syn
3	97	G.E.	1200	60	4150 Syn
1	75	G.E.	1500	250	230/460 SC
1	60	Whse.	1200	60	2300V
3	60	EM	1200	125	230
1	30	Whse.	900	250	460
2	30	G.E.	1750	240	230/460
1	25	G.E.	1800	250	230 V Syn
1	20	EM	1800	125	220 V
1	7½	Allis	1800	125	230/440
2	5	G.E.	1800	125	230/440
3	1½	G.E.	2850	500 cy 1 ph	230/440
2	3	G.E.	1800	250	230/440

DC, 230 VOLT MOTORS

Qu	HP	Make	Speed	Type
1	300	G.E.	1200	MPC
2	150	C.W.	900	WP
1	125	G.E.	1700	RC
1	75	C.W.	900	WP
1	30	C.W.	700	CM
1	25	G.E.	900	RC
1	25	Whse.	835	SK

FOR POWER

J.L. HEMPHILL & CO.

---

750 KW TURBINE-GENERATOR

200-400 lb., 600°, extraction 0-40 lb., exhaust 28.5 in., including condenser, relief valves, voltage regulator, differential relay protection and other auxiliaries. Very carefully maintained.

W. H. BRACKETT COMPANY

31 ST. JAMES AVE., BOSTON 16, MASS.

COMPLETE POWER PLANTS

STEAM — ELECTRIC — HYDRO — DIESEL

BOILERS *"Export Orders Carefully Executed"* **BOILERS**

TRY US with your INQUIRIES for ALL POWER MACHINERY

CHARLES B. REARICK 30 CHURCH ST. NEW YORK 7, N. Y.

FOR SALE

POWER EQUIPMENT

1—400 KW G.E. 400# 12# Back 550° T.T. Geared Turbo Generator. 600V 60 cy. 3 ph. .70 P.F. New 1948, Excellent.

2—300 KW G.E. 400# 2# Back. with 400 sq. ft. surface cond. air ejectors circulating pumps, etc. New 1944, with switch panels, voltage regulators, etc. Excellent. 550V 3 ph 60 cy. .80 P.F. will reconnect for 480V.

2—B&W F.F. 15-24 Boilers 450# 550° T.T. 25,000# per hr. complete with Detroit Spreader Stokers and B&W conversion oil burners, forced draft fans induced fan cinder trap and cinder return systems, with Hays Cochran comb. control panel. Stokers will be sold separately if desired.

1—125 H.P. 1740 R.P.M. West. Motor-Style 1077767 insulated for 2300—will reconnect for 2300. New condition.

MERRIMAC HAT CORPORATION

AMESBURY, MASS.

BOILERS

Bought • Sold • Rented

10 H.P. Package Units 100-150 lbs. Ames, Cyclotherm—Superior—Steamaster.
25 H.P.—125 Lb.—Ames—Gas Fired
50 H.P.—125 Lb. Cleaver-Brooks #5 Oil
150 H.P.—125 Lb.—Cyclotherm #6 Oil
Valve Reseating Sets for Globe Valves
¼" to 6" and 6" to 12"
FREDERICK STOKER (new in Crate) 450 H.P., 1,600,000 B.T.U. Dowtherm Boiler, 30 Drums Ariclor For Same.

BOILER & EQUIPMENT CO.
743 Bedford Ave. Brooklyn 5, N. Y.
ULster 5-2588

MOTOR GENERATOR SET

500 KW.

WESTINGHOUSE FACTORY SET

250 V D.C.—2000 AMPS., 900 RPM—714 HP, Synchronous motor drive, 3 ph. 60 cy. 2200 volts. Steel Base—Full commutator, Serial #4979931. Complete magnetic auto-transformer reduced voltage, A.C. starter and D.C. panel.

BENSON-WILIMZIG, INC.
1704 North 8th St.
Phone GArfield 1-4290
St. Louis 6, Missouri

FOR SALE
TRANSFORMERS

1—G.E. 5000 KVA, 6900/2300v., 3 ph., 60 cy., type HT—Form DA, 2½% Taps, above and below normal, impedence 5.32% at 6900v.

4—Al. Chal. 667 KVA, 2300/460v., 1 ph., 60 cy., Type DSC, 4—2½% Taps below normal—45% impedence.

FS-6247, POWER
330 W. 42nd St., New York 36, N.Y.

APPLICATION ENGINEERS

30 Years experience serving the USER with electrical equipment to BUY or SELL. Send your INQUIRIES and AVAILABLE EQUIPMENT list to

H. BLAINE JOHNSON & ASSOCIATES
58 W. Jackson Blvd., Chgo. 4, Ill.

CENTRIFUGAL PUMPS

3—20" Centrifugal Pumps 15000 GPM (Worthington pumps) 35' T D H, driven by 200 HP Gen. Elect. Motors, 2300 volt 220-440 720 RPM.

PAUL OBERMAN
1910 Delmar, St. Louis, Mo.

There's more than 40% to 60% SAVINGS on

SCHOONMAKER DEPENDABLE DIESEL POWER

because:

Each Schoonmaker-sold Diesel Engine Unit is fully REMANUFACTURED in our plants by highly skilled, factory-trained Diesel engineers. Only genuine factory-made and approved parts are used and all REMANUFACTURING is in strict accordance with manufacturer's recommended procedures. Prior to shipment every engine is subjected to a FULL LOAD operating test in accordance with DEMA standards.

The Schoonmaker Plants and Warehouses located in Eddystone, Penna. and Sausalito (San Francisco), California give NATIONWIDE SERVICE from Coast to Coast with modern, efficient and reliable facilities.

Our reputation and many years of experience and SPECIALIZATION in Diesel power equipment gives you value that money cannot buy elsewhere.

So—Buy SCHOONMAKER because you buy the FINEST in DEPENDABLE DIESEL POWER.

A PARTIAL LIST OF OUR INVENTORY

KW	MAKE	MODEL	HP	RPM
1180	Worthington	SEH-8	1685	360
1136	Fairbanks Morse	38D	1600	720
1100	General Motors	16-278A	1600	720
1000	General Motors	16-567B	1440	720
750	General Motors	12-567	1080	720
700	Worthington	EE-8	1000	327
672	Fairbanks Morse	38D	960	720
*500	Alco	6-12½x13T	750	600
500	General Motors	8-567	720	720
*350	Baldwin	VO-6	510	450
320	Superior	60-S-6	460	450
*320	Enterprise	DSG-6	460	450
300	Fairbanks Morse	32E14	450	300
300	General Motors	8-268A	450	1200
200	General Motors	8-268A	350	900
*160	Buckeye	80	240	600
148	Fairbanks Morse	32E14	225	300
100	General Motors	3-268A	150	1200
60	General Motors	6-71	90	1200

ALTERNATING & DIRECT CURRENT UNITS STANDARD AND SPECIAL VOLTAGES AS REQUIRED

**—indicates NEW unit*

ONE YEAR GUARANTEE!

A.G. *America's largest source of New and Remanufactured Diesel Power*

SCHOONMAKER CO., INC.

50 CHURCH ST., NEW YORK 7, N. Y.
PLANTS AND WAREHOUSES:
Eddystone, Penna. and Sausalito (S.F.), Calif.

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130 HP 600 RPM Superior Diesel Engine
75 HP C.W. Slip-ring Motor 1160 RPM with Automatic Reduced Voltage Starter.
Universal Uniflow Skinner Steam Engine 100 HP.

JOHN F. CARSON
A. & Venango Sts. Philadelphia 34, Pa.
GArfield 6-2221

O'Brien Offers—

MOTOR GENERATOR SETS

1—500 KW Crocker Wheeler CCD, 250 volt 720 RPM with 750 KVA Cr. Wh. Syn. Motor 3/60/2300 V. A.C. & D.C. Panels.
1—300 KW West. 3 wire 125/250 Volt 1200 RPM Generator (1938 year). Can furnish with suitable motor. Advise Requirement.
2—250 KW Burke 125 V. 435 KVA Syn. M.D. 3/60—any voltage
1—150 KW G.E. Type MPC—250 Volt 1200 RPM 3/60/2300/200 H.P. Syn. Motor Drive A.C. & D.C. Panels
1—100 KW G.E. RC 17, 125 v. 3/60/220/1200 rpm
1—100 KW Al. Ch. 250 V. 1200 RPM 150 HP. Syn. Mtr. 2/60 or 3/60 any voltage.
1—75 KW Burke 250 V. 900 RPM 115 H.P. Burke—Syn. M.D. 2 or 3 ph. any voltage.
1—62½ KW 125 volt Hertner, 1200 rpm, 100 HP Sn. Cr. 3/60/220
1—60 KW G.E. 250 V. 1200 RPM 90 HP 220/3/60/SYN.

DIESEL GENERATOR SETS

3—625 KVA Inger. Rand, 3/60/480/720 rpm
2—438 KVA GM-Winton 3/60/2300/360 rpm
1—375 KVA GM 8-268 Diesel 3/60/2400
3—200 KW GM Diesels Twin 671—3/60/220/1200 RPM
1—300 KW GM 8-268 Diesel 125/250 V. D.C.
3—100 KVA Cooper Bessemer 3/60/440
1—37.5 Kato 3/60/220 Continental Gas
1—25 KVA LeRoi Gas 1/60/120/240
1—10 KW Wincharger 1/60/110-220 Gasoline

BOILERS

1—120,000# Erie-N, 250 PSI, 1945
1—60,000# Erie Stoker New 160 psi
2—50,000# Erie-N, 250 PSI
2—300 H.P. Cleaver O.B. 30 Package 150 PSI
1—300 HP Keeler CP—160 Lb. Oil
4—6000# C.E. 375#—1952 Comb #6 oil—gas
1—120 H.P. Int CR 352—125# W.P. #2 oil —1947
1—100 H.P. Clayton, 150# Oil fired
2—80 H.P. Cleaver Brooks 125# W.P. #2 oil
1—50 H.P. Clayton, 150# Oil fired
1—50 H.P. Amesteam, Package 125 PSI
1—15 H.P Ontario 100# W.P.—1949
1—10 H.P. McKee 100# W.P.

ELECTRIC MOTORS

QU.	HP	Make	Type	Volts	Speed
1	500	West.	CS	6600/2300	514
1	450	A.C.	ANY	2300	600
1	400	West.	CW	440	514
1	400	G.E.	Syn.	2300	450
1	350	G.E.	MT18	2300	400
2	200	West.	CW	2300	1800
1	200	G.E.	I.M.	440	514

JUST PURCHASED
3—300 H.P. General Motors Twin 6-71 Radiator Cooled Heavy duty Diesel Power Units New 1952—used 200 hrs.

TURBO GENERATORS

1—11250 KVA G.E. 3/60/13200/3600 rpm—Condensing—Boilers—Complete Plant

2—4000 KVA Allis Chalmers 3/60/2300/3600 rpm—Condensing
1—1250 KVA DeLaval Non-Cond. 3/60/2300. New 1940 340 psi 50 lb. B.P.
1—938 KVA GE-Terry Aut. Extr. 3/60/480 150 psi. 30 lb. B.P. Surf. Condenser 1934
1—780 KVA G.E.-Moore 3/60/2300/3600 RPM Non-Cond. 180 PSI 35 lb. B.P. New 1936.
1—75 KW G.E. Non-Cond. D.C. 125 volt.

AIR COMPRESSORS

1—1600 cfm IR PRE-2 Syn. Mtr. Dr. 3/60/2300—100 psi.
2—1300 cfm IR-PRE-2 3/60/2300—100 psi
1—978 CFM Sullivan 15x13x8, 45 psi.
1—900 CFM C.E. 17x10x12—M.D. 2/60/220
1—871 CFM Schramm 7½x6x4. 100 psi
1—368 CFM I.R. 12x10, 100 P.S.I.
1—173 CFM Chicago NSB 100 psi

OISC TRANSFORMERS

Qu.	KVA	Make	Pri. V.	Sec. V.	Phase
3	2000	G.E.	13200	230/460	1
3	1000	GE	13200	2300	1
1	1100	West.	4160	440	3
1	750	O'Brien New	13200	480	3
3	667	Al. Ch.	33000	2300	1
3	500	Wagner	33000	2400/4160Y	1
1	500	Gregory	4160	440	3
3	400	GE	2400	460	1
3	333	Pitts.	33000	2300	1
3	333	G.E.	13800	240/480	1
3	250	Al. Ch.	13,200	115/230	1
3	250	Penna.	34500	120/240	1
3	167	G. E.	12000	2400	1
3	150	G.E.	13200	2300/4000Y	1
3	150	West	2400	230/115	1
3	100	G.E.	13200	120/240	1
3	100	West.	4160	240/480	1
3	25	Atlantic	2400	240/120	1

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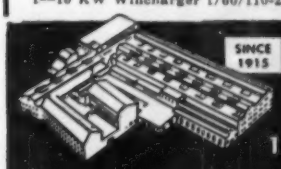

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15—25 KVA 60 cy 1 ph. Dry Type 240/480—120/240
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3—50 KVA 60 cy. 1 ph. Dry Type 240/480—120/240.
3—10 KVA 60 cy 3 ph. Dry Type 480—208Y/120.
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160 CFM	Worth (gas) portable
168 CFM	125 psi 8½x9 Worth
211 CFM	100 psi 9x8 Ing. Rand ESI
254 CFM	100 psi 10x10 Ingersoll ER-1 40 HP Elec
268 CFM	800 psi 10/4½x10 Ingersoll 75 HP Synth
278 CFM	125 psi 2 stage Chicago PB-50 HP Elec
294 CFM	125 psi 10x11 Worth—HB
291 CFM	40 psi 3 cylinder Ingersoll Type 40
343 CFM	500 psi 11/8x13 Worth Elec or steam
354 CFM	vacuum 14x5 Ing
360 CFM	125 psi 12-7½x10 Penn
460 CFM	125 psi 13/9x10 Ingersoll XRB—Duplex
500 CFM	Chicago (Diesel) portable
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1184 CFM	Vacuum 22x8 Penn 7AT
1292 CFM	35 psi 20x13 Chicago T-B 125 HP Elec
1351 CFM	125 psi 18½-11½x8½ Worth YC2
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1681 CFM	Vacuum 24x15 Chic. TB
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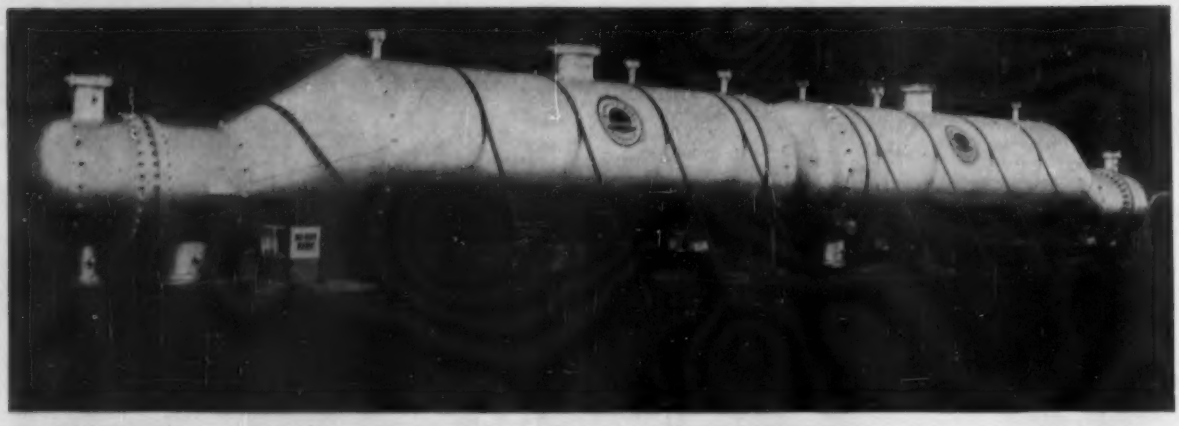

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